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THE ENGINEER

The British Industries Fair at Birmingham

Descriptive Supplement No. 2

INTRODUCTION

IN this, our second supplement descriptive of the exhibits at the British Industries Fair, we continue an account of the more novel items of engineering interest on view at the Engineering and Hardware Section at Castle Bromwich, Birmingham. Last week a similar supplement was published, whilst in the body of the paper there appeared a brief account of scientific instruments and equipment to be seen at Olympia, London.

An article which accompanies this supplement contains further descriptions of the Birmingham exhibits, whilst succeeding issues of THE ENGINEER will contain an account of the items of which details were not available until the fair was opened.

W. CANNING AND CO., LTD.

Plant designed to carry out the recently introduced "Lumax" bright nickel plating process are exhibited by W. Canning and Co., Ltd., Birmingham. The solution employed in this process produces a bright nickel alloy deposit that can be taken directly to the bright chrome plating tank without the intermediate polishing of the nickel deposit that has been necessary hitherto. The process yields a ductile nickel deposit of unusual brilliance, which, in conjunction with bright chrome produces a handsome durable finish. Permissible current densities are higher than is usual for dull nickel; densities up to 45 amperes per square foot are quite common, although a value of 36 amperes per square foot is probably more suitable for general-purpose plating.

Typical installations are shown in the accompanying engravings. Fig. 1 illustrates the plating vats installed in the Greet, Birmingham, works of the James Cycle Company, Ltd. The plating tanks are rubber lined and are provided with heating, filtering and air agitating apparatus. Depolarising anodes are used, and the solution is worked at a temperature of approximately 140 deg. Fah.

Filtration is of considerable importance, since it is essential that the solution should be kept free from suspended particles of matter. Unless such particles are removed they are liable to be occluded in the deposit, causing roughness, which makes it difficult to obtain a good finish. An efficient system of filtration is the only way to ensure absolute cleanliness. To meet this exacting requirement the vats are provided with a new design of filter press fitted with non-metallic plates which will not distort or break. These plates with the inserted filter cloths present solution-tight joints. The metal ends supporting the filter plates are rubber covered to prevent corrosion by the solution and to ensure that the solution itself cannot suffer contamination arising from rust. The filter press has a capacity of 1200 gallons per hour.

Four metal rectifier units, as illustrated in Fig. 2, comprise the power and control equipment for the plating installation. The incoming power supply at 400 V, three-phase, 50 cycles is controlled in each unit by a contactor and an auto transformer with two switches giving voltage regulation in fifteen steps. Each unit has an output of 750 A at 6 V. The oil-immersed, water-cooled rectifiers are housed in rectangular steel tanks.

RAPID MAGNETTING MACHINE COMPANY, LTD.

Among the many designs of magnetic separators, extractors, lifting magnets, clutches, & c., to be seen upon the stand of the Rapid Magnetting Machine Company, Ltd., Lombard Street, Birmingham, is the latest "Rapid Multi" self-cleaning, chute type separator. This machine has been developed to deal with various materials containing either a small or a large percentage of magnetic material, and to run continuously without stopping for cleaning down.

As can be seen from the illustration in Fig. 3, it is mounted upon a rigid fabricated steel framework, which requires no special foundations and need not be bolted down, as there is no vibration or stress transmitted when the machine is running. In operation the material to be cleaned is fed evenly to the belt in the chute, which travels slowly upwards, its face being adjusted at a suitable angle so that the material travels down the chute by gravity. Whilst the material moves downwards, it is constantly coming into contact with magnetised feelers and any iron in it is held, the cleaned material falling out of the bottom of the chute by gravity.

The chute consists of a stationary electro

FIG. 1—BRIGHT NICKEL PLATING—CANNING

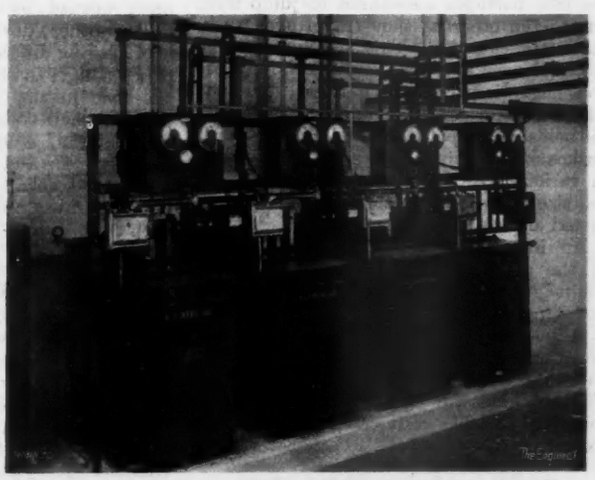


FIG. 2—RECTIFIER PLANT FOR BRIGHT NICKEL PLATING—CANNING

magnet, made up of a series of alternate polarity poles, over which runs an endless belt fitted with steel inserts called feelers. These feelers are arranged in staggered rows on the belt, and each has a number of edges which become highly magnetised from in-

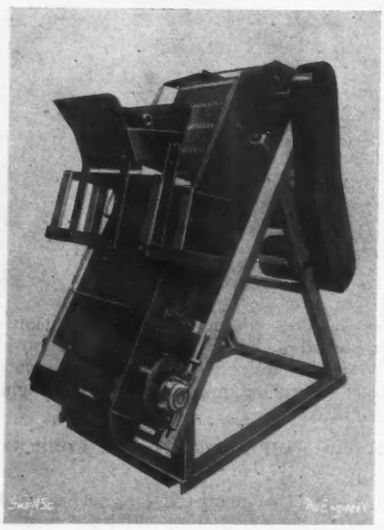


FIG. 3—SELF CLEANING MAGNETIC SEPARATOR—RAPID MAGNETTING

duction from the magnet units below the belt. They hold the particles of iron extracted from the material gravitating down the chute until they reach the top pulley, where they pass out of the magnetic field into a "neutral" zone. At this point they automatically release the iron which falls over the back of the material chute into a waste chute.

As the magnets are of alternate polarity, the iron particles are caused to jump from one to the other as they travel over alternate magnet poles. This action turns the material over and over and allows only its non-magnetic particles to gravitate down the chute. There are a large number of feelers on the belt and as the material sliding downwards strikes one after the other it is presented in various positions, so that, irrespective of its size, the iron content is readily contacted and retained.

An intensifier plate fitted to the front of the chute not only serves to increase the magnetic pull but also prevents material bouncing down and forwards. This plate is adjustable, so that the gap between it and the belt can be regulated, according to the feed and the material being treated. The machine can be arranged for individual motor drive or it can be driven from existing line shafting.

THE RAWLPLUG COMPANY, LTD.

Two fixing devices which are of interest to the engineer are on view on the stand of the Rawlplug Company, Ltd., of Cromwell Road, London, S.W.7. Each has been developed for making firm fixings in wall and partition boards, hollow bricks, sheet metal, &c., in which it is difficult to use screws, nails or nuts and bolts, particularly where there is no access to the reverse side of the material.

The gravity toggle, illustrated on the left of Fig. 4, comprises a metal member and nut threaded on to the end of the fixing screw, so designed that the nut can swivel about a point near one end of the member. When swivelled close to the screw, the member can be pushed through a hole in the material, whereupon its longer end falls downwards by the action of gravity. The screw is then turned until the member is drawn tightly against the back of the material.

Another type of Rawlplug toggle device, known as a spring toggle, is also illustrated in Fig. 4. Giving a similar result to the gravity toggle, its purpose is achieved by two wings which, when drawn together, can be passed through the hole, but which when in the void behind the material open outwards by the action of a spring.

The other device, the "Rawlanchor," is of entirely different construction. It comprises a flexible shell, which is pushed into the hole in the material. When screwed up, the shell collapses against the back of the material, as shown in the third sketch of Fig. 4, and becomes "anchored" within the hole. The screw can therefore be withdrawn and replaced at any time, with the result that tapped holes are avoided.

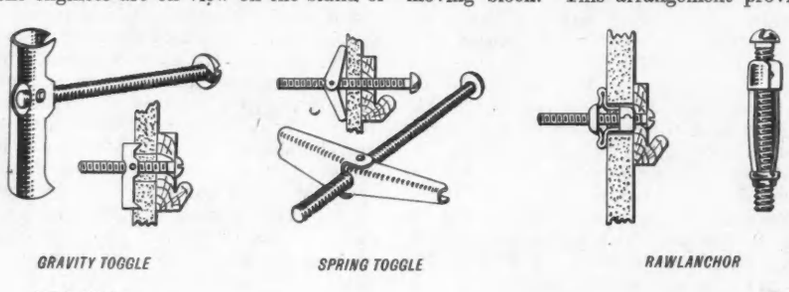


FIG. 4—FIXING DEVICES—RAWLPLUG

FERRANTI, LTD.

Special interest attaches to the design of the micro-gap pre-payment switch which is fitted in all modern a.c. pre-payment meters manufactured by Ferranti, Ltd., Hollinwood, Lancs. Demonstrated as a corporate part of a cutaway model of the standard F.L.P. meter, the switch consists of two contacts having a large surface area, mounted in a fixed block, while the moving contact comprises a flat copper bar mounted in a moving block. This arrangement provides two gaps, each of the order of 0·01in, in series.

As is well-known, the failure of any switch to interrupt current successfully is due to an arc persisting across the contacts. Arcing is a condition of intense ionisation, so that any switch that prevents or limits ionisation should have an inherently good performance.

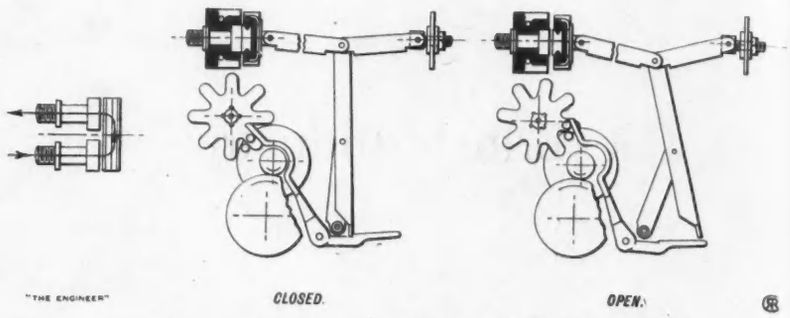


FIG. 5—MICRO-GAP SWITCH TOGGLE MECHANISM—FERRANTI

In the Ferranti micro-gap switch rapid de-ionisation is initiated as the current wave passes through zero, inhibiting re-establishment of the current during the succeeding half-cycle of the voltage wave. Rapid de-ionisation is assisted by a number of factors. Because the gap is small, the volume of ionised gas is correspondingly small, and there is less gas to be de-ionised. In addition the voltage drop across the contacts, being proportional to the length of the gap, is small, so that little energy is available for re-ionisation. The existence of two gaps in series enables the available energy to be dissipated more easily, and the effect is enhanced by the use of heavy contacts having a large surface area, which quickly absorbs heat from the ionised gases.

A copy of an actual oscillogram is reproduced in Fig. 6 to illustrate the severest operating condition. The break itself occurs in 0·0002 seconds between the points A and B. Between the points B and C the switch is allowed to arc, and between the points C and D the gap is de-ionised. From the point D onwards the current remains at zero. It should be noted that the volt drop across the contacts during the whole arcing period is relatively low.

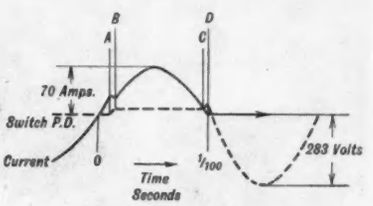


FIG. 6—MICRO-GAP SWITCH OSCILLOGRAM—FERRANTI

The general principles of the operating mechanism are shown diagrammatically in Fig 5. A double toggle device reduces the mechanical loading of the tripping system to a very low value. Nevertheless, a pressure of 60 lb per square inch is available to close the switch contacts. This pressure, together with the large surface area of the contact faces, results in a constant resistance of only 0·005 ohms.

As a measure of its carrying capacity, the switch is stated to have withstood a short-circuit of 1500 A for one second without any damage. It is claimed, further,

that under working conditions the switch can be relied upon to interrupt 12½ kW two thousand times without any sign of contact deterioration. During the movement of closing, a wiping action takes place between the contacts, removing any particles of dust that might otherwise impair the electrical contact.

Other exhibits shown by Ferranti, Ltd., are representative of the work and products of the firm's instruments, electronics and transformer departments, including a rotary type on-load tap-changing gear for h.t. power transformers, and a moving-coil regulated distribution transformer for the fully automatic control of substation l.t. busbar voltage.

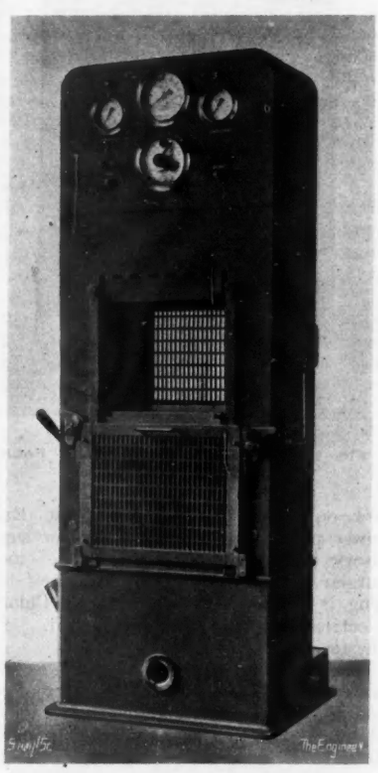


FIG. 8—PLASTICS PRESS—TURNER

TURNER MANUFACTURING COMPANY, LTD.

A new hydraulic press which has been developed for the plastics industry by the Turner Manufacturing Company, Ltd., of Villiers Street, Wolverhampton, incorporates a number of interesting features. As can be seen from the engraving, Fig. 8, this machine is totally enclosed and presents a clean, modern appearance. It is fully self-contained and is capable of exerting any required pressure between 10 tons and 50 tons. The platens are 15½in by 15in and when fitted with hot plates have a maximum daylight between of 14½in.

The top platen is fixed, and the lower platen is raised and lowered by a ram actuated by a compact hydraulic unit situated in a tank which forms the base of the machine. The ram has a maximum stroke of 12in. A single lever at the side of the machine controls ram movement, the speed of which can be set to 2in per second on closing and 1½in per second on opening. Hydraulic power used to withdraw the ram can be set to exert any required mould opening force between 1 ton and 5 tons.

The moving platen is guided between bevelled slides machined in the inner faces of the press frame, and it has guide blocks which are adjustable to take up any wear. These guide blocks are made of porous bronze impregnated with oil and require no lubrication. When the control lever is released the ram is locked in that position, and the machine incorporates comprehensive interlocking systems between the ram and the guards. The front guard is in two portions; the lower one is fixed and the upper one slides down in front of it. A fixed guard is provided over the rear opening of the press and sliding doors on each side can only be opened when the front guard is down.

Oil under pressure is supplied to the ram by one of the firm's automatic variable delivery, high pressure pumps, driven by a flange mounted motor at 1440 r.p.m.

One of these pumps is illustrated in the engraving, Fig. 7, and the diagram, Fig. 9. In this pump a rotor A, revolving on a stationary ported valve B, has in it seven radially disposed bores. In each of these bores or cylinders is a piston C, having at its outer end a slipper D attached by a cross pin. The slippers, pressing on a track ring E, which is mounted on the pump casing eccentric to the ported valve, cause the pistons during each revolution of the pump to make one suction and one pressure stroke. Oil is drawn into the cylinders through the suction port, the pump casing and the end of the ported valve remote from its point of support. Pressure oil is delivered into the hydraulic circuit through the delivery port, which is drilled in the opposite end of the valve.

The track ring is pivoted at F in the pump casing and its position in relation to the ported valve is controlled by a small hydraulic plunger G, connected to the pressure circuit, acting against the spring H. The initial compression of the spring can be varied by means of a small handwheel.

It will be appreciated that the pump gives a full output of oil until a given pressure is reached—that is, when the spring load is balanced by the oil pressure in the delivery circuit transmitted to the plunger G. Any further tendency towards a rise in pressure actuates the plunger automatically to force the track ring over to the zero stroke piston position against the spring pressure. If the outlet from the pump is completely shut, the pump ceases to deliver and the track ring takes up a position where the volume of oil forced into the circuit is only that required to make up any leakage within or without the unit.

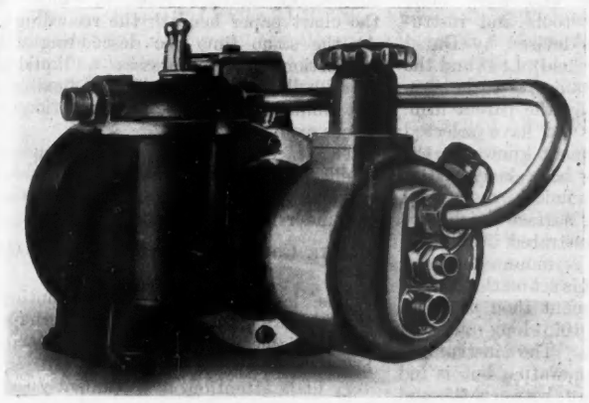


FIG. 7—HIGH PRESSURE OIL PUMP—TURNER

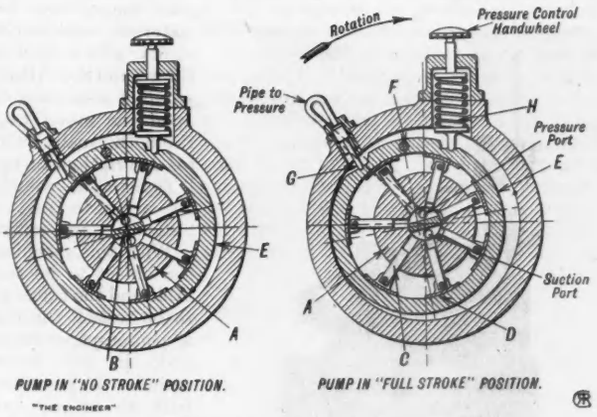


FIG. 9—DIAGRAM OF OIL PUMP—TURNER

Any tendency for the pump to heat up when idling at full pressure is prevented by a cooling circulation of oil throughout the casing. Due to the action of the rotating parts of the pump, oil drawn in through the suction port in the casing deflects the revolving oil from the casing back into the tank. In this way a continuous circulation of cooling oil at low pressure is set up within the pump.

It is stated that idling pressure can be varied in the pump from 500 to 2500 lb per square inch, and once set remains constant.

GIRDLESTONE AND CO.

Among the pumps to be seen working on the stand of Girdlestone and Co., of 23, Davies Street, London, W.1, is a redesigned and improved model of the firm's glandless diaphragm pump for dealing with acids and corrosive liquids. This redesigned pump, to be seen in Fig. 10, has increased accessibility to the working parts, and the rubber valves can be quickly removed without disturbing the diaphragm or pipe connections.

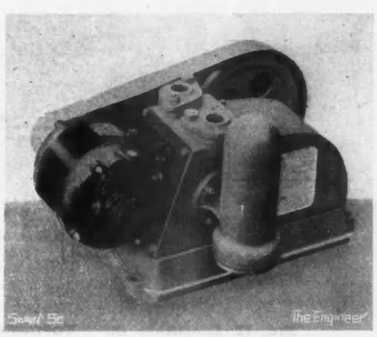


FIG. 10—DIAPHRAGM PUMP—GIRDLESTONE

The pump has a heavy cast iron body lined throughout with ebonite and is fitted with moulded rubber valves. The suction and delivery connections are faced with ebonite, rubber jointed and fitted with counter-flanges. Its mechanism is of simple design,

FIG. 11—"TOPOGRAPH" SURFACE RECORDER —DAVID BROWN

consisting of a driving shaft running in taper roller bearings. The shaft through an eccentric and a heavy connecting-rod transmits 375 pulsations a minute to a reinforced moulded rubber diaphragm. The pump is mounted on a substantial cast iron bed and is driven through a vee belt by a ½ h.p. or a ¼ h.p. electric motor according to the duty.

When fitted with low-pressure valves the pump has a fresh water output varying from 300 gallons per hour at nominal head to 120 gallons per hour at 40 lb pressure. With high-pressure valves its output is increased to 350 gallons per hour at nominal head and 100 gallons per hour at 100 lb pressure.

DAVID BROWN AND SONS, LTD.

A representative selection of the gears and gear units, cast bronze and alloy steel materials, and ancillary tools and instruments, which have been devised by David Brown and Sons (Huddersfield), Ltd., and the group of associated companies, is to be seen upon the stand taken by the parent firm. From the many exhibits we have selected for description an instrument known as the "Topograph," which has been developed as an accurate and economical means of measuring and recording surface finish.

With this machine, illustrated in Fig. 11, the object to be tested is mounted on the table and the tracer point is set on the surface to be tested, the instrument then produces a pen-on-paper record 10in long and 5in wide in two minutes. The instrument includes no electrical apparatus, but is fed with air at any pressure between 35 and 90 lb per square inch. Power is provided by a falling weight which is first raised by a winding handle on the side of the machine.

Although the instrument is normally used for flat surfaces, it can be applied to any curved surface that contains a straight line along which the tracer point can traverse. From the pen record the heights of the irregularities of the surface are directly determinable in micro inches by multiplication by the particular conversion factor for which the instrument is set. It is stated that irregularities in the order of 2 micro inches are readily discernible when the instrument is set at a magnification of 20,000 to 1.

The principle upon which the pen operating mechanism works can be followed with reference to the diagram Fig. 12. The projecting end of the tracer arm is provided with a spherically mounted skid, which rests on the surface to be tested. The diamond tracer point A passes through the centre of the skid and is held in contact with the surface to be inspected with a force of a few milligrammes, which is applied by a light spring. The tracer point is carried by the short arm of a pivoted lever B, at the other end of which is a vane or "chopper" C. Movement of the tracer actuates the vane, which partially intercepts a jet of air directed at a pressure of 12 lb per square inch at an orifice 0·020in in diameter. The pressure built up at the orifice is transmitted through an air line to a relay D. This relay operates from a separate air line, at a pressure of 20 lb per square inch, and applies proportional pressure to a spring-loaded diaphragm E, which operates the pen lever F.

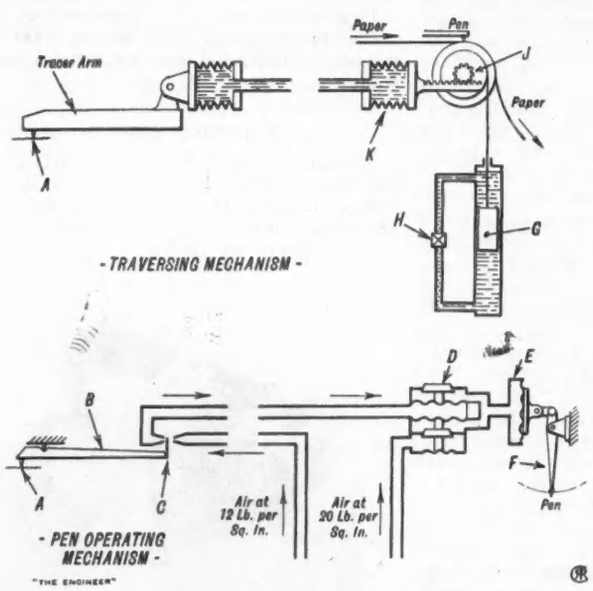


FIG. 12—DIAGRAM OF "TOPOGRAPH" MECHANISM —DAVID BROWN

The ratio of pen movement to tracer movement may be set between 10,000 and 20,000 to 1, so that a pen movement of 0·1in corresponds to a roughness depth of 10 micro inches or 5 micro inches, according to the setting of the instrument.

The diagram also shows the arrangement of the weight-operated tracer traversing mechanism. The motive power comes from the falling weight G, which also acts as a piston to force oil through a throttle valve H from one end of its cylinder to the other. The adjustment of the valve controls the speed of descent of the weight or piston. In falling, the weight rotates a roller J, which draws the chart paper beneath the recording pen. At the same time the descending weight proportionately compresses a liquid-filled metal bellows K, connected by a flexible pipe to a similar bellows which gives motion to the tracer arm.

The tracer head is adjustably mounted on a pillar at the rear of the machine table and can be set to record surfaces up to 18in above the underside of a component.

THE CHLORIDE ELECTRICAL STORAGE COMPANY, LTD.

The lead-acid battery on continuous-trickle charge provides what is perhaps the most reliable source of energy for tripping high-tension switchgear and, since it requires very little attention, it is eminently suitable for unattended sub-stations. An interesting new equipment of this kind, the Exide power pack, which can be used for supervisory equipments, electric impulse clocks, burglar alarms, as well as for switch tripping, is shown on the stand of the Chloride Electrical Storage Company, Ltd., Manchester.

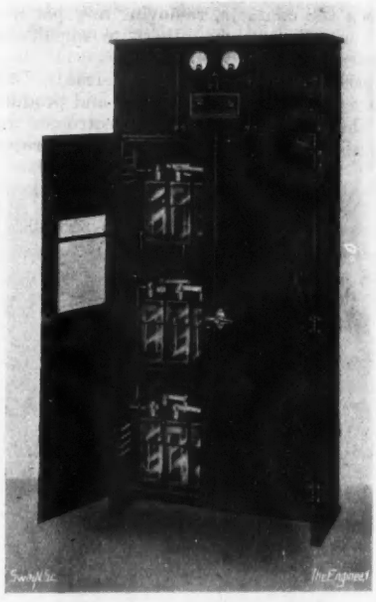


FIG. 13—SWITCH-TRIPPING POWER PACK —CHLORIDE ELECTRICAL

The complete equipment, which is illustrated in Fig. 13, consists of a battery of cells contained in a cabinet, complete with trickle-charge and testing gear, which is accommodated in a detachable chassis in the upper compartment of the cabinet. Referring to the simplified circuit diagram reproduced in Fig. 14, a double wound vacuum impregnated transformer feeds a full-wave selenium rectifier; cartridge type fuses are provided in the a.c. supply and rectifier output circuits. On the output side current and voltage are measured on two 2½in dial moving coil instruments scaled, respectively, 0–50 mA and 0–50 V, and a test resistance is included to allow the battery voltage to be measured on load. A rotary resistance for output control and a retractive switch complete the control and test equipment. The standard trickle-charge gear is designed to operate from 200–250-V, 50 cycles mains, with an output

variable between 8 and 50 mA. Alternatively, apparatus suitable for 100–110 V, 50 cycles can be supplied.

Two alternative types of cell are available—"low loss," or Planté—and in either instance the battery is dispatched from the works fully charged and ready for immediate service. The low-loss cell (LLF or LLM) has pasted plates and is similar in general construction to the mass type of cell. The plates, however, are of a special low-loss design to reduce self discharge on open circuit to a

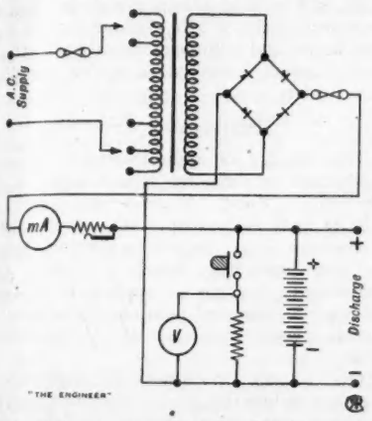


FIG. 14—SIMPLIFIED CIRCUIT OF SWITCH-TRIPPING GEAR—CHLORIDE ELECTRICAL

minimum and to allow the cell to retain its original characteristics over a long period. Separators are dispensed with, for the plates are of substantial construction and are spaced well apart in separate grooves in moulded glass boxes. The Planté cell (ASG7 or ASG2), which is supplied as an alternative, is of the design used for stationary duties; it has Planté positive plates and negative plates of the box type.

The cabinet, as illustrated, is built of angle iron and sheet steel; it is designed for floor fixing, but provision is made for wall mounting. The main battery compartment is fitted with three shelves with space for a reserve supply of distilled water and a hydrometer. Anti-corrosive finish is applied to the whole of the cabinet, and as a further measure of protection the cells stand on

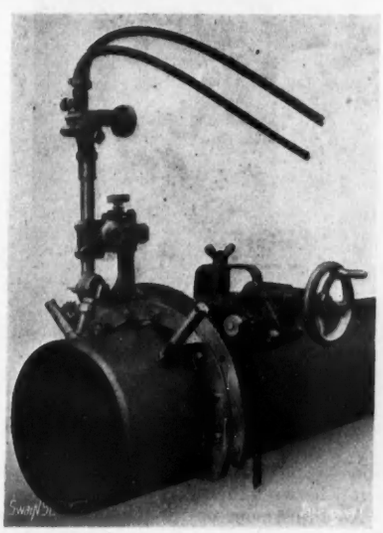


FIG. 15—TUBE CUTTING MACHINE—HANCOCK

wooden boards resting on the steel shelves; these boards also provide additional insulation from earth.

As an alternative to steel, a cabinet constructed of hardwood can be supplied. This cabinet contains four compartments. Two of these compartments house the battery and are fitted with glass doors; a smaller compartment contains the electrical equipment, while immediately below this is a space for a reserve supply of distilled water and a hydrometer. With low-loss cells the wooden cabinet is designed for mounting on a substantial shelf, but the cabinet for Planté cells is arranged for floor mounting.

HANCOCK AND CO. (ENGINEERS), LTD.

In order to provide a quick and accurate means of parting-off steel pipes in the field, a range of portable oxygen cutting machines has been introduced by Hancock and Co. (Engineers), Ltd., Progress Way, Croydon, Surrey. These machines are made in four standard sizes for pipes from 3in to 6in diameter, from 6in to 12in diameter, from 12in to 18in diameter and from 18in to 24in diameter. One of the machines can be seen in the photograph we reproduce in Fig. 15.

The main framework of the machine consists of front and rear plate assemblies, which are oxygen-cut out of steel plate and rigidly held together by tie bars. Each of the assemblies carries a pair of feet, which support the machine on the upper part of the pipe being cut. These feet are well spaced to give a firm seating, and their length can be adjusted in order to accommodate the machine to the various pipe diameters within its scope. The machine is rigidly held in its working position by means of a chain, which is passed round the lower part of the pipe and tensioned with a wing screw to force the pipe up against the feet.

On the main front assembly is mounted a horseshoe-shaped carrier, the gap in which is sufficiently wide to pass over the largest diameter of pipe for which the machine is designed. Mounted on this carrier, and engaged in a grooved path round its outer circumference, is a runner of similar shape, on which is fixed the cutter bracket. A length of standard roller chain fixed round the outer edge of the runner forms a rack, through which it is driven round the carrier and the pipe set in its centre. Two sprockets driving the runner are spaced sufficiently far apart to bridge the gap in its circumference and give a continuity of drive as the runner passes round the carrier. The sprockets are turned by a handwheel driving through a worm and worm wheel, one sprocket being mounted directly on the worm shaft and the other being driven either by a roller chain or a bevel shaft.

The oxy-acetylene burner arm is mounted on the centre of the runner and set in radial relationship to the centre of the pipe. The length of its arm can be adjusted through a rack and pinion to suit the diameter of the work. Two types of burner heads can be used with the machine, a single head for cutting at right angles or at a bevel, or a twin head burner for cutting at a bevel with a root face.

A floating head can be fitted to the burner assembly to maintain the nozzle at a constant height above the pipe surface and compensate for any eccentricity and irregularity in the pipe.

Another piece of equipment to be seen in operation on the stand is the tube end profile cutting attachment on a "Simplex" cutting and profiling machine, illustrated in Fig. 16. In this equipment the profile on the end of a tube is reproduced from that of a template.

The template is mounted at one end of a rotatable shaft carried in a bracket which is substituted for the normal template table of the machine. At the opposite end of this shaft is a face-plate, to which is clamped the tube to be profiled. The upper transverse carriage of the machine is locked so that the tracer head with the magnetic drive and also the cutter are only free to move longitudinally. When the direction of travel of the cut

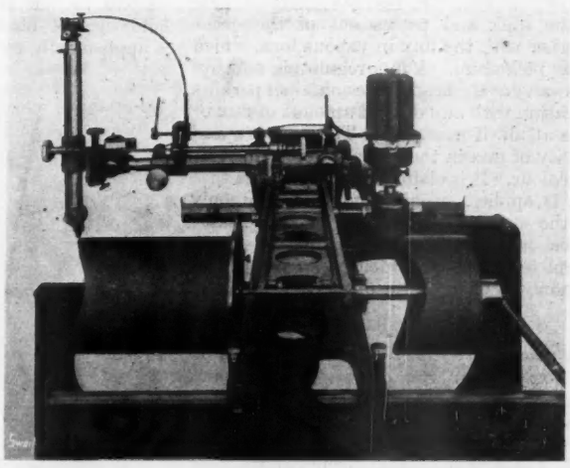


FIG. 16—TUBE PROFILING ATTACHMENT—HANCOCK

is longitudinal the tracer, together with the carriage and burner, move longitudinally. But when the direction of cut changes through 90 deg. and becomes circumferential the tracer and burner remain stationary whilst the

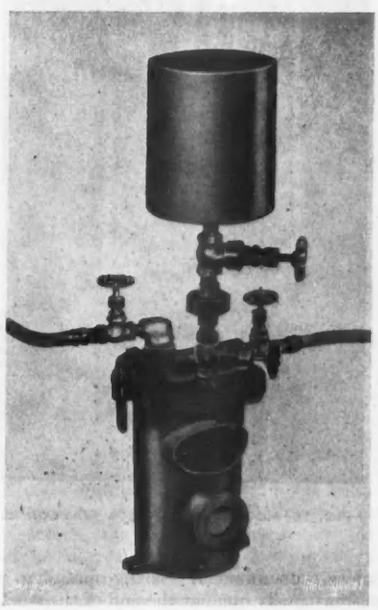


FIG. 17—GAS FLUXER—HANCOCK

magnetic drive rotates the template and with it the tube being cut. Any other direction of cut which is a combination of longitudinal and circumferential movement is made by a combination of these movements. In

this way a profiled tube can be cut to a developed shape for welding into a main; an aperture of any required shape can be cut in a tube in any position, the cut being always radial to the axis of the tube.

On this stand an associated company, Weldcraft, Ltd., is exhibiting the "Gasflux" process, which has been developed for use in the welding of steel and other metals with bronze rod. For this process, flux in the form of suitable ingredients carried in solution in a highly volatile liquid is introduced directly in the gas line and discharged through the tip of the welding torch with the flame.

The apparatus used for the process, illustrated in Fig. 17, consists of a container partly filled with the liquid flux, which saturates a cotton wick or filter in the upper half of the tank. The fuel gas enters one side of the tank and passes out of the other together with the flux in vapour form which it has picked up. A flux regulating and by-pass valve at the head of the container permits operation with any desired amount of flux or none at all, if necessary. The presence and density of flux in the flame is determined by the colour. It is claimed for this process that flux is applied evenly and smoothly only at the point required, leaving no residue to be cleaned off when welding has been completed. It also effects considerable economy in the amount of welding rod used.

TAYLOR AND CHALLEN, LTD.

A machine specially designed for the production of hot brass pressings, and which incorporates automatic vice, side and bottom movements, is to be seen in the range of presses on the stand of Taylor and Challen, Ltd., Constitution Hill, Birmingham. The press, illustrated in Fig. 18, is designed for operation with split dies which totally

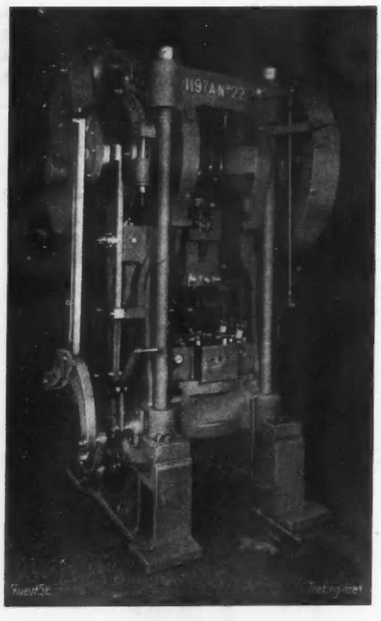


FIG. 18—HOT BRASS PRESS—TAYLOR & CHALLEN

enclose components during pressing and automatically open at the end of the working stroke return movement. The closing and opening of the die vice is effected through toggle gear worked through links and levers by a cam on the crankshaft. Additional levers on the toggle links of the vice action are engaged by rubbing pieces on the main slide to give a positive holding action to the vice and avoid, to the greatest possible extent, the formation of flash on the components.

The side motions of the press consist of slides on each side of the vice having transverse movements, operated by the main slide. As the slide descends, the ends of the side motions can be arranged to enter each side of the die space to form cores over which the pressed articles are extruded. To operate the bottom motion, links and levers extend from a crankpin at the end of the crankshaft, to an eccentric shaft below the bed of the machine. This eccentric shaft operates a connecting-rod and slide, working in a vertical position, to which a punch can be fixed. As the main slide descends the bottom motion slide rises and pushes the punch into the die cavity to form a core for the pressing.

A hand lever at the side of the machine enables the die to be closed sufficiently to hold the hot blank in position until power is applied fully to close the dies, after which

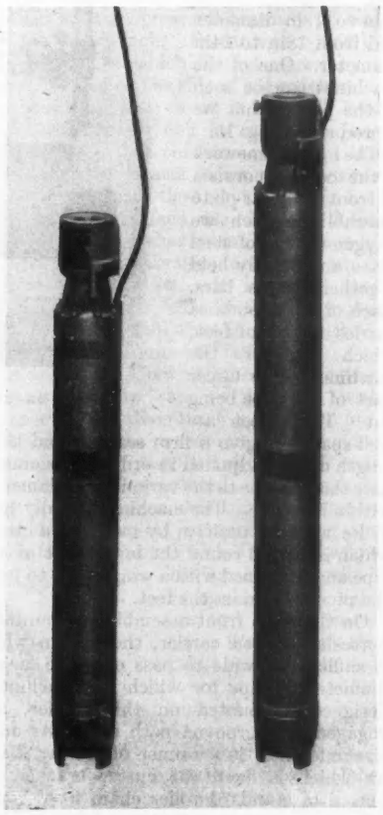


FIG. 19—SUBMERSIBLE BOREHOLE PUMPS—BERESFORD

the working cycle is completed automatically.

The machine is capable of exerting a pressure of 100 tons at the bottom of its stroke, and is usually arranged to operate at sixty strokes per minute, its stroke being 8in long.

JAMES BERESFORD AND SON, LTD.

Two of the latest types of Beresford submersible electric pumps are shown in the form of static and working exhibits on the stand of James Beresford and Son, Ltd., of Mackadown Lane, Marston Green, Birmingham. Such pumps are suitable for raising water from deep wells or boreholes and for dewatering collieries or waterlogged excavations. The design is claimed to achieve a particularly high output for the relatively small overall diameter, as is indicated by the pumps shown in Fig. 19, which have a maximum capacity of 550 gallons per hour, against a total manometric head of 165ft. Although the motor is rated at 1·2 h.p., the pump is suitable for installation in boreholes as small as 4in in diameter. A larger type of pump, similarly built, is rated at 150 h.p., 2½ million gallons per day, 222ft head, suitable for installation in boreholes of 14in diameter or more. Components of these submersible pumps are of bronze and stainless steel.

Other exhibits on the company's stand are fire-fighting pumps, the firm's centrifugal, self-priming pump, which is designed for a suction lift of 27ft, without the use of a foot valve, and a 2in centrifugal contractors' pump, which is shown in action pumping dirty water.

REDIFFUSION, LTD.

The display of radio-frequency heating equipment shown by Rediffusion, Ltd., Broomhill Road, Wandsworth, London, S.W.18, includes examples of three branches of the technique: induction heating applied to case hardening, brazing, melting and soldering; heating as applied to thermo-setting plastics, and equipment for welding thermo-plastic material on a production scale.

One of the machines demonstrated is a plastic welder designed to meet the need for a quick, economical method of fabricating thermoplastics in sheet, strip or tubular form. This equipment, illustrated in Fig. 20, is known as the "Redifon" Model JP1, and is powered by the "Redifon" RH22 generator, forming a compact unit of comparatively low initial cost and having the small power consumption of one unit per hour. The welder consists of a rigidly constructed foot-operated press with a platform carrying the insulated brass socket that holds the lower electrode. A substantial counterbalanced arm carries the upper electrode, which is brought down by depression of the control pedal, to grip the material firmly between the two electrodes.

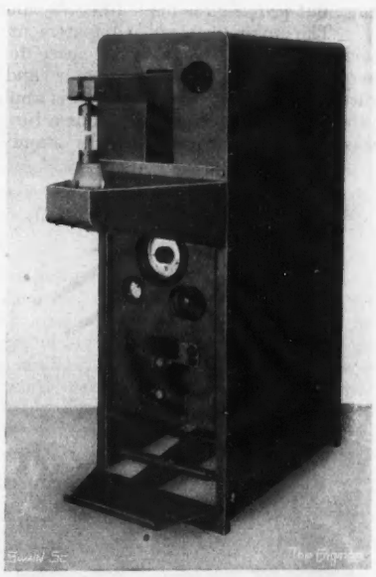


FIG. 20—PLASTIC WELDER—REDIFFUSION

An adjustment on the moving arm allows the exact minimum gap required to be set within 0·001in, eliminating any risk of the electrode piercing the material. An additional adjustable control switches on the power as soon as the desired pressure on the material has been attained.

A variety of interchangeable electrodes

or press tools is available, so that the machine can handle different classes of welding work, ranging from a straight strip or seam weld 10in by $\frac{1}{8}$in to shaped welds within an area of 6in by 4in. A total weld area of $1\frac{1}{4}$ square inches is within the capacity of the equipment, and by performing consecutive operations the operator can complete long seams or large built-up patterns without difficulty. The three standard electrode sets supplied with the J.P.1 equipment will make welds 6in by $\frac{1}{8}$in, 3in by $\frac{1}{8}$in, or a $\frac{1}{2}$in dia. spot. Experience has shown that these sizes are sufficient to cover a wide range of work, but the makers are prepared to design and manufacture special electrodes to suit the customer's individual requirements.

The radio frequency generator for energising the electrodes is fitted with an automatic process timer, which switches off the power when sufficient time has elapsed to make the weld.

Various devices are incorporated to ensure safety in operation. Apart from the switch that makes the electrodes "dead" until pressure is applied to the material, radio frequency power is automatically switched off by the process timer on completion of the weld, or by the release of the spring-loaded operating pedal. As long as radio frequency power is applied to the electrodes a red indicator lamp remains alight, while the lower "live" electrode is so protected by insulating material that an r.f. burn is virtually impossible. Since the upper electrode and its supporting arm are at earth potential, no protective insulation or covering is needed to complete the protection that is afforded against electric shock.

G.W.B. Electric Furnaces, Ltd.

The "Autolec" steam raiser manufactured by G. W. B. Electric Furnaces, Ltd., Dudley, Worcestershire, embodies advantages which should appeal to many users of steam in industry, in dairies and in hospitals. A completely self-contained unit, the "Autolec" steam raiser comprises a boiler, water pump, feed tank, circuit breaker, and automatic control gear, compactly grouped on a totally enclosed stand, as illustrated in Fig. 21.

Steam can be raised within five to ten minutes from cold, so that, without inconvenience, fuel costs can be saved by tripping

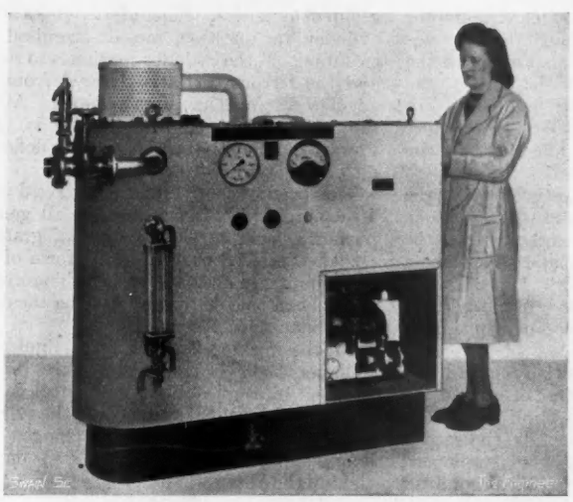


FIG. 21—ELECTRODE BOILER—G.W.B.

out the circuit breaker during lunch breaks, &c. Since the boiler is automatically controlled, no attendance is required beyond the operation of switching on and off.

The equipment is an electrode boiler, designed on the principle that the cross-section of the conducting path is governed solely by the effective area of the electrode, that is, the effective area immersed in water.

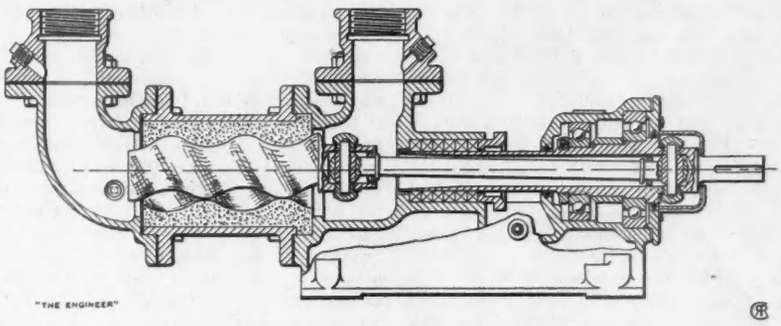


FIG. 22—SECTION THROUGH PUMP—MONO PUMPS

Automatic regulation of the steam raising process is achieved by controlling the water level, as described more fully below. By employing the control of water level, it is possible to eliminate the mechanical complications involved in adjustable electrodes or adjustable shields which vary the electrode area immersed in water.

Electrical load regulation, that is the kilowatt dissipation of the boiler, is controlled by an automatic load regulator consisting of a calibrated and adjustable rheostat, which covers the range from 20 to 115 per cent of the specified rating of the boiler. A single-pole relay closes and opens automatically, depending on the current taken by the boiler. On closing the main oil circuit breaker the feed pump delivers water to the base of the boiler shell, and the current increases as the water level in the boiler rises. When the current reaches the value for which the adjustable rheostat has been set, the relay operates and opens an electrically actuated valve allowing water to pass from the boiler back to the hot well tank. The water level in the boiler therefore falls, reducing the electrical load until the point is reached when the relay opens and causes the "overflow" valve to close.

Thus the relay causes the water level to fluctuate between narrow limits above and below the mean value corresponding to the loading for which the rheostat has been set. By this arrangement it is possible to control the loading to within about 5 per cent of the required value. The feed pump, which is housed in the base of the unit, is driven continuously at constant speed by a small direct-coupled electric motor.

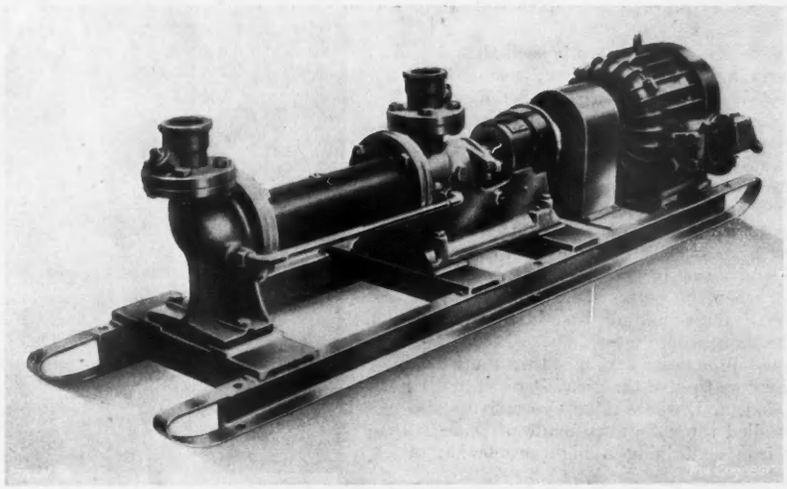


FIG. 23—MINE PUMP—MONO PUMPS

Control of pressure is effected by a combined pressure regulator and indicator, which can regulate the pressure within limits of $\pm$ 2 lb per square inch at any pressure from 0 to 120 lb per square inch. Should the pressure in the boiler reach the value at which the regulator is set the electrically operated valve is opened so as to lower the water level in the boiler and so reduce the loading.

The equipment illustrated in Fig. 21 is suitable for a 400-V, 3-phase, 50-cycle supply and has a nominal rating of 70 kW and a steam raising capacity of 320 lb per hour. As stated above, the automatic load regulator allows the actual loading to be adjusted to any value between 20 and 115 per cent of this nominal rating. The "Autolec" steam raiser can be supplied to order in sizes and ratings designed to suit the prospective user's requirements.

Mono Pumps, Ltd.

On the stand taken by Mono Pumps, Ltd., of 67, Clerkenwell Road, London, E.C.1, can be seen a representative selection of the

firm's pumps specially adapted for use in various industries. These pumps can be designed to handle clean, dirty or corrosive liquids of high or low viscosity. They are all built on the same working principle and the drawing reproduced in Fig. 22 shows a typical general arrangement.

The pump consists essentially of a hardened corrosion-resisting metal rotor of helical spiral form, which rotates in a stator of natural or synthetic rubber with a slightly eccentric motion. The inner surface of the stator is formed as a double helix, whilst the helical rotor has a single scroll, the pitch of which is half that of the stator. In operation, the rotor has a composite motion, being turned about its axis by the rotation of the pump shaft, while, simultaneously, the axis itself moves in a small circle in the contrary direction. The geometry of the design is such that each cross section of the rotor traverses the stator in a straight-line path, in a plane perpendicular to the stator axis, the stator being shaped internally to accommodate this motion. By this arrangement the rotor maintains a constant seal across the stator, and this seal travels continuously along the stator to produce a uniform and positive displacement of liquid.

The design of the pump is such that it is self-priming even with high suction lifts, and retains this characteristic when handling sands or grit-laden fluids. Its rubber stator and metal rotor combine to give high degree of abrasion resistance and are self-lubricated by the liquid being pumped.

The pump illustrated in Fig. 23 is designed for mine work and is fitted with a snorer by-pass, which is provided to circulate sufficient water for lubrication through the stator when the pump is drawing air. It is mounted on a mining base-plate together with a flameproof motor.

These mine pumps are fitted with nitralloy steel rotors to give the greatest resistance to abrasion, and, where mildly corrosive water is handled the rotors are made of a special cast iron containing a high proportion of nickel.

Electromagnets, Ltd.

A magnetic separator incorporating a number of novel ideas in design is one of the interesting exhibits shown by Electromagnets, Ltd., Birmingham. The Boxmag "Rotocyl" magnetic separator was evolved and developed by a firm of British metal refiners to meet its own needs, and the equipment, as now manufactured by Electromagnets, Ltd., is suitable for dealing with metal swarf, rubber, powders, foodstuffs, granular materials, &c., not only for extracting ferrous elements, for their own value, but alternatively for concentrating or purification processes.

In the form illustrated in Fig. 24 the separator consists of twin units, one of which can be cleaned while the other is in use, so that uninterrupted flow of the material can be maintained. Each of the units consists of a hollow rotating cylinder, through which the material is fed either by hand or from a storage hopper. The material traverses the inclined cylinder under the influence of gravity. Throughout this process the cylinder is made to rotate continuously, spilling the material over a series of longitudinal ribs which run the whole length of the cylinder. As the material cascades freely over the ribs it comes under the influence of the magnetic fields associated with a system of fixed electro-magnets which are disposed around the outside of the rotating cylinders. During its passage through the cylinder the ferromagnetic material is separated and retained while the "purified" material is discharged on to a gravity-loaded bridge or chute.

The cylinder, 6ft long by 18in diameter, is made of brass, reinforced with eight longitudinal ribs and a series of strengthening and retaining rings. Two machined flanged steel track rings are fitted and the cylinder is supported thereby on four idler rollers which are free to revolve on bushed pins, each attached to eccentric bosses, facilitating adjustment to compensate for wear. The whole assembly is mounted on a structural steel framework, which in turn can be mounted on wheels where portability is required.

Rotation of the cylinder is produced by a drive situated at the feed end. A totally enclosed continuously rated electric motor drives a countershaft through a twin vee rope. A chain drive links a sprocket on the countershaft with a chain wheel fitted to the outside of the revolving cylinder. In multiple units embodying two or more cylinders the drive is modified to suit the method of operation required.

Probably the more interesting part of the equipment is the magnetic field system, which is in two zones. Commencing from the feed end of the machine, that is, the remote end in the view reproduced in Fig. 24, while the material is in the first zone of the cylinder it comes under the influence of a magnetic system produced by poles of alternate polarity fixed circumferentially round the cylinder. Approximately 98 per cent of the ferrous material is extracted and retained in this portion of the cylinder. In the second zone a different magnetic system is employed; the magnets, which again are fixed round the cylinder, are connected so as to produce a field having alternate polarity longitudinally. A number of equally spaced wedge-shaped rings are fitted inside this portion of the cylinder, as shown in the illustration. These rings are magnetised by induction and the small quantity of ferrous metal still remaining in the material is held in the pockets formed by the wedge rings.

From the cylinder the non-ferrous material is discharged on to a gravity loaded collapsible bridge. This bridge is pivoted near its centre and, as long as the magnet coils are energised, a separate actuating coil holds the bridge in the position shown and discharge of the finished product proceeds normally. This actuating coil is in series with the magnet coils, and when the latter are de-energised either intentionally or through any failure in supply, the actuating coil allows the bridge to tilt upwards and deflect the material leaving the cylinder into a separate container. A similar sequence takes place when it is desired to remove the ferrous metal from the cylinder or from one of a group of cylinders. When the magnets of the cylinder in question are de-energised by switching off, the cylinder continues to rotate and the ferrous metal is released from the pockets where it has been trapped. At the same time, the collapsible bridge is tilted upwards so that the ferrous metal is deflected into a separate receptacle.

The speed of the cylinder is arranged to be 40 r.p.m., which is suitable for all general purposes, such as the treating of granular or flaky material or stuff in the form of dry free-running lumps. A considerable range of control can be achieved by varying the angle of inclination of the cylinders.

All the working parts of the equipment as well as the electro-magnets are totally enclosed in a substantial sheet steel casing. Access to the magnet system or to the cylinder drive can be gained through hinged side doors, one of which can be seen on the right of the illustration.

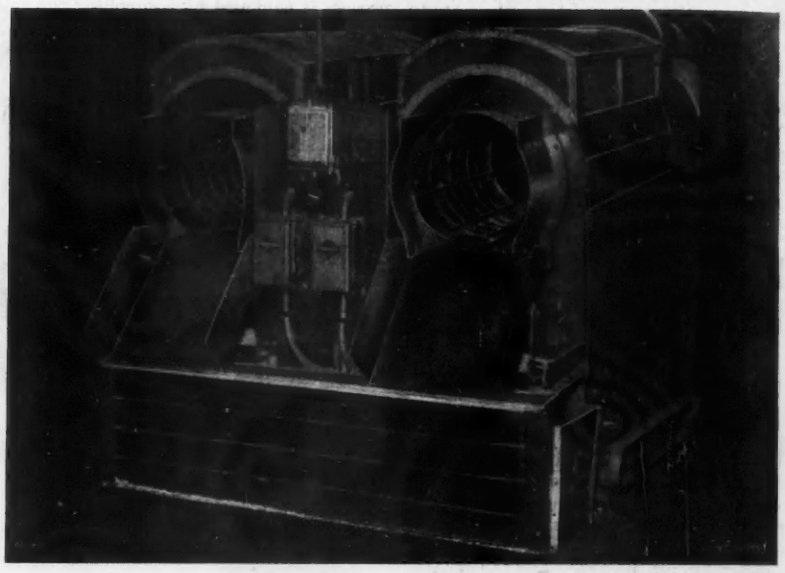


Fig. 24—Twin Unit "Rotocyl" Magnetic Separator—Electromagnets

A Seven-Day Journal

L.M.S Stafford Collision Report

THE Ministry of Transport report of Colonel A. C. Trench, who was assisted by Brigadier C. A. Langley, on the inquiry into the accident which occurred at 7.16 p.m. on December 7, 1946, at Stafford, on the Trent Valley Line of the London, Midland and Scottish Railway Company, has now been printed by the Stationery Office. We may recall that the 4.35 p.m. local passenger train from Coventry to Stafford was standing on the down fast line with the engine opposite to the Stafford No. 4 signal-box when it was run into at the rear by the 3.45 p.m. double-headed express passenger train from Euston to Liverpool. One passenger died in hospital from an illness which was accentuated by the accident, one was taken to hospital and six suffered from minor injuries. None of the company's staff was injured. As a result of the collision the local train was driven forward 90 yards and the rear coach was telescoped for 16ft by the leading engine of the express. Both the second and third coaches of the local train were telescoped for 12ft. Fortunately, the rear coach of the local train was practically empty. The centre longitudinal member of the rear coach of the local train penetrated the smoke-box of the leading engine. There was no derailment, but slight damage was done to the permanent way and the signal fittings. In his conclusion, Colonel Trench says that he thinks it is clear that the responsibility for the accident must rest on Signalman Baker in that he accepted the express before the Coventry train had actually passed through his section. A failure of a fireman's call pillar was, he suggests, a contributory factor in the circumstances which led to the accident. In his remarks and recommendations, Colonel Trench says that it is probable that the provision of a track circuit in No. 2 platform would have prevented Signalman Baker from wrongly imagining before accepting the express that he saw the tail light of the local train at a platform of Stafford station. Track circuiting on a more extensive scale is very desirable at Stafford, as at many other busy stations, but the programme has been delayed owing to war conditions, and is still affected by post-war shortages of material and labour. The circuits of the fireman's call pillar are at present tested once a month, but Colonel Trench suggests that the railway company should consider the desirability of more frequent inspections in the case of the older equipments of the open-circuit type.

The Manchester Joint Research Council

THE Manchester Joint Research Council, reference to which has already been made in these columns, is composed of members from the University of Manchester and the Manchester Chamber of Commerce. It has just completed its second year of activity. Outstanding events in the period 1945–46 were Sir John Anderson's address on "Science and Reconstruction" and the conference on "Research and the Smaller Firm." More recently the Council made a survey into the needs of industry in the matter of university graduates. A series of publications on research and industry has been begun and investigations started by the Council, the results of which will be available for members. With a view to increasing its activities over the widest possible field, the Council is now proposing to institute an associate membership which will be open, on payment of an annual subscription of one guinea, to all who have a practical interest in the application of research to industry and commerce. Associate members will receive free of charge all the official publications of the Council, together with such other literature as the Council may circulate to its members. They will have the right of attendance, without charge, at all the conferences and meetings which the Council may arrange, other than its Council business meetings. The information bureau and the services of the executive liaison officer would be at their disposal and meetings of associates would be arranged from time to time. It is hoped that groups of associate members might be formed in convenient localities and that study circles might be initiated with local conferences and inter-group meetings, in addition to the participation of associate members in the public activities of the parent body. The Chairman of the Council, Mr. A. H. S. Hinchcliffe, D.L., would welcome inquiries from those who are interested in this new development. Such inquiries should be addressed to the Chamber of Commerce, Ship Canal House, King Street, Manchester, 2.

Education for Management

IN October, 1945, a Committee was appointed under the chairmanship of Lieut.-Colonel L. Urwick to advise the Minister of Education on educational facilities required for management in industry and commerce, with particular reference to the steps to be taken in regard to the organisation of studies, bearing in mind the various requirements of professional organisations and the need for their co-ordination. Several professional bodies were represented on this Committee, the report of which was published early this week by H.M. Stationery Office (price 6d.). It is estimated that industry and commerce already employ nearly 500,000 men and women in managerial posts and that recruitment at present is at the rate of 12,000 a year. The report stresses that young men and women cannot be trained as managers by theory alone, and urges that practical experience and the right qualities of character are very essential. It is recognised, however, that courses of study have an important place in training and the demand for such courses in technical and commercial colleges has grown rapidly in recent years. At the same time it has been found that the requirements of many professional bodies have varied greatly, a matter which has created a serious problem for the colleges and has tended to dissipate their facilities. The Committee proposes therefore that common syllabuses should be adopted, with provision for a certain variety in the later stages of the course, and model syllabuses for intermediate and final examinations are recommended in the report, the Committee believing that these will enable the needs of the individual student and of the professional bodies to be met. Further recommendations of the Committee are that steps should be taken at once to increase the supply of trained teachers in management, both part-time and full-time, and that a commission of inquiry should visit the U.S.A. to investigate and to report on the facilities for education in management in that country. The Minister of Education has accepted the report, and has asked local education authorities to establish courses on the lines recommended.

Coal Output and the Five-Day Week

ALTHOUGH it is not customary for the Ministry of Fuel and Power to issue weekly figures relating to coal output, an exception has been made for the week ended May 10th, in view of the interest aroused over the introduction of the five-day week in the coal mines. The Minister of Fuel and Power, Mr. Shinwell, announced on Tuesday that last week's production of deep-mined coal was 3,552,600 tons and of open-cast coal 199,400 tons, making a total output of 3,752,000 tons. Production in the week ended May 3rd—the last six-day week—amounted to 4,100,000 tons, of which 3,839,700 tons was deep-mined coal. Commenting generally on the first five-day week in the mines, Mr. Shinwell said that it was adversely affected by the unofficial strike of winding engine men in Durham, a minor dispute in Lancashire and by two days' statutory holiday in Scotland. These disputes and holidays, it was estimated, accounted for a loss of 263,190 tons of coal. The returns from the regions, however, were for the most part satisfactory, although Mr. Shinwell pointed out that, having regard to holidays and stoppages caused by breakdowns or accidents, a weekly output of deep-mined and open-cast coal of about 4,000,000 tons was not sufficient to enable the calendar year target of 200,000,000 tons to be reached. Last week's output, Mr. Shinwell added, was up to the average of recent weeks, when the loss caused by holidays and disputes was taken into account, but it was, of course, impossible to form a sound conclusion on the effect of the five-day week on a single week's operations. The output of deep-mined coal last week, however, was above the minimum estimate of production on a five-day week basis.

Electricity Industry Organising Committee

IN the House of Commons on Tuesday, May 13th, Mr. Shinwell, the Minister of Fuel and Power, announced that he had decided to set up an organising committee for the electricity industry in order to shorten the interval between the passage of the Bill and the vesting date, since one of the most important tasks of the new Authority would be to press on with the provision of new generating plant by the earliest possible date. The following have accepted the Minister's invitation to serve on the Committee :—Lord Citrine, Chairman ; Sir Johnstone Wright, General Manager, Central Electricity Board ; Mr. J. Hacking, Chief Engineer, Central Electricity Board ; Lieut.-Colonel E. H. E. Woodward, general manager, North-Eastern Electric Supply Company ; Mr. J. Eccles, city electrical engineer, Liverpool Corporation ; Mr. E. W. Bussey, general secretary of the Electrical Trades Union. In addition, the Committee will have the advice and assistance of the Electrical Commissioners. Mr. Harold Hobson was, Mr. Shinwell said, resigning the chairmanship of the Central Electricity Board as from July 31st next, and in order to facilitate the arrangements for setting up the new organisation under the Electricity Bill Sir Johnstone Wright had accepted his invitation to succeed Mr. Hobson during the interim period until the Central Electricity Board was taken over by the British Electricity Authority. In view of his new duties, Lord Citrine was resigning from the National Coal Board, and the Minister had appointed Sir Joseph Hallsworth to succeed him.

The British Association Meeting at Dundee

THE first great annual meeting of the British Association for the Advancement of Science, to be held since 1939, will be held in Dundee from Wednesday, August 27th, to Wednesday, September 3rd. The President is Sir Henry Dale, and the keynote of the meeting will be "Swords into Ploughshares." "Science in Peace and War" is the subject of Sir Henry's Presidential Address. The President of Section G, Engineering, is Sir William Halcrow, and his address will be "Progress in Modern Engineering." Sir Edward Appleton, the President of Section G, Mathematics and Physics, has chosen as the subject of his address, "Earth, Stars and Radio." In Section G, Geology, the President, Dr. M. Macgregor, has chosen as his subject, "Geology in the Development of the Coalfields." Among the discussions in the various sections are those on "Peacetime Applications of Nuclear Fission," "Hydraulic Models," "Scottish Water Power Developments," "Coal as a Source of Heat and Power," "The Mechanisation of Collieries, with Special Reference to Coal Cutting Machinery," while other subjects include "Men and Machines," "Selection for Management," and "Incentive and Industrial Efficiency." Excursions have been arranged and there will be visits to industrial works in Dundee and district.

Sazillism: Its Origin and Evolution

By S. LELIAVSKY BEY

No. III—(*Continued from page 395, May 9th*)

6.—More Recent Stress Investigations

ANOTHER application of Airy functions which cannot be passed over without comment in even the briefest of reviews of modern dam theory was presented in a paper by Mr. Brahtz, read before the A.S.C.E. in 1935.[11] These results have subsequently been referred to in highly authoritative technical reports as "the nearest approach on record to date of the exact solution of the actual distribution of stress throughout the body of a dam and its foundations for perfectly elastic materials."[12]

The stresses are calculated by Mr. Brahtz from the composite form

$$F = \Sigma F_n$$

in which F_n are a number of Airy functions, corresponding to various individual effects, on which depends the elastic stability of the dam and its foundation; from among these

$$F_1 = -P(x^3k^3 + 2y^3 - 3xy^2k)/6k^3$$

and

$$F_2 = [(K^2-2)vy^3 + 3vk\,xy^2]/6k^3$$

yield Sazilly-Levy stresses for water pressure and structural weight, respectively.

It follows, therefore, that this investigation is another instance belonging to that class of methods in which secondary effects are superposed upon the basic solution of Sazilly. These effects disappear almost entirely in the upper part of the dam but are more pronounced near the foundation, particularly in the re-entrant corners at heel and toe. The most important secondary effects are obtained from "corner functions" which are generally used for calculating the stresses at an elastic wedge or corner. They are defined in such a way as to give no stress on the straight part of the boundary.

The results obtained by Brahtz for the Morris dam in California are shown in Fig. 9, alongside those of Wilson and Gore experiments. In spite of what has been said on the subject by some authors, there does not seem to be much similarity in the general outline of the curves.

Brahtz's paper calls, also, for mention as containing an attempt at explaining lucidly in commonly used engineering terms and simple formulæ, the general theory of the Airy function, as applied to dams. That it was thought necessary, or advisable, to incorporate such an explanation in a rather advanced technical publication was in itself perhaps significant; for it supplied additional evidence testifying to the fact that the cycle of publications on the dam theory based on Airy functions (among which the paper under review was possibly the most prominent example) did not fully succeed in bridging the chasm between the practising engineer and the highly specialised analyst; in fact, these publications, if anything, seemed to have broadened the chasm.

In referring to some of such investigations in a recent paper on the stress problem, Mr. D. McHenry said: "These presentations are rather too mathematical for many practising engineers and they have the additional practical disadvantage that they deal with the equation $\nabla^4 F = 0$, which is related to the strain through a rather circuitous route. This equation has dominated the field of two-dimensional elasticity since its introduction in 1862, and its utility is beyond question; nevertheless, it is a rather unnatural approach to the stress problem."[13]

Though it does not refer specifically to dams, this abstract from McHenry's paper is, nevertheless, of considerable interest in connection with the subject treated in these pages, for it is symptomatic of a new tendency in the general solution of the problem. In addition to what Mr. McHenry writes, we might also point out that the great practical objection against using Airy functions lies in the rigidity of the method, as even the smallest of alterations of the standard outlines often causes considerable mathematical difficulties and modifies substantially the symbolical transcription of the solution, For practical application, the method should possess greater elasticity, in order that the designer may have a free hand in exercising his creative capacity. It is therefore not surprising that the exaggerated importance which at times has been attributed to the Airy method has finally led to a certain feeling of disappointment, and that other solutions have recently become more popular.

In particular, we should mention as an interesting instance the principle of "lattice analogy," advocated by McHenry (*loc. sit.*), Mr. A. Hrennikoff ("Plane Stress and Bending of Plates by Method of Articulated Framework"), and others. In order to understand the substance of this method, reference may again be made to the squares in Fig. 7. Could a stress-distribution be found, such that each square was in equilibrium and in contact with its neighbours, then such a distribution would be an approximate solution, the degree of approximation depending solely on the size of the elementary square. A purely numerical trial-and-error method might actually be used, but it would prove extremely laborious. But a solution has been suggested by means of which the calculation may be systematised into a feasible scheme; each square is artificially replaced by a lattice frame consisting of six members, as shown in Fig. 13(*d*).

In order to equalise the conditions there must be a certain analogy between the deformations of the prototype (solid square (*c*)) and its model (lattice frame (*d*)). It can be shown that this condition can be transcribed in the form of two equations, as follows:—

$$AE_N = 3Elt/8 \quad \text{and} \quad AE_D = 3Elt\sqrt{2}/8$$

in which AE_N is the product of the sectional area by the Young Modulus for the horizontal and vertical members of the frames;

AE_D is the same for diagonals;
l is length of element;
t is thickness of slab.

Strictly speaking, these equations are valid only when Poisson's ratio is equal to 1/3; but this constant has a relatively small influence on the result, and the formulæ can, therefore, be used as a general "approximate" solution.

The structural element under consideration, for instance, the profile of a gravity dam, can be replaced by a latticed framework possessing approximately the same elastic properties, and the problem of finding the stresses in the members of this framework is substituted for the stress analysis in a plane slab. It is true that the new problem is by no means a simple one, since the degree of redundancy of a composite structure consisting of a large number of braced square frames is very high, and the direct solution involves dozens and dozens of simultaneous elastic equations. Still, there are several approximate solutions, based on the "relaxation" principle, which can be used to convert the process of successive approximations into a calculation capable of being performed in an engineering office. It is, therefore, believed that the "lattice analogy" solution may eventually develop into a method which will place the pure elastic analysis of a dam at the disposal of the practising engineer.

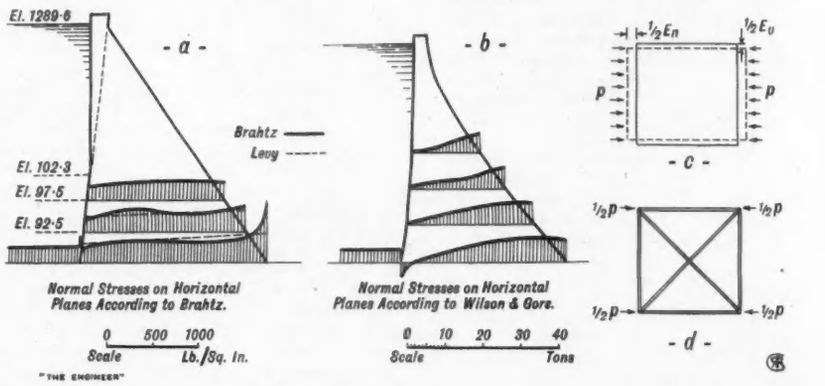


FIG. 9—NORMAL STRESSES ACCORDING TO BRAHTZ, WILSON AND GORE

7.—Stress, as the Safety Criterion, Questioned

It will be observed that in all the examples, so far quoted, we have been dealing with one side of the problem only, the calculation of the intensity of the unit stress. It remains now to consider what criterion should be used, in assessing the true value of the result so obtained as an indication of the safety or otherwise of the dam. In this connection it is rather important to bear

[11] "The Stress Function and Photo-Elasticity Applied to Dams," by H. A. Brahtz, "Transactions," No. 101, 1936.

[12] "Symposium on Masonry Dams," by A. L. Alin, quoted from a pre-printed copy, dated 1938.

[13] "A Lattice Analogy for the Solution of the Stress Problems," by Douglas McHenry, *Journal* of Inst. C.E., 2, 1943–44, December, 1943.

in mind that the method of stress analysis and the criterion adopted in estimating the permissible limit of the calculated stress are always related so that when one of them is changed—for whatever reason—the other one must be altered accordingly. If that relation were to be neglected, we would arrive at inconsistent, or even absurd, results. For it often happens that new and more elaborate research leads to the detection of a higher and therefore more dangerous order of stresses in a class of structure the usual dimensions of which extensive practice has demonstrated to be fully safe. Should, then, the old criterion be used in conjunction with the new method of stress analysis, or vice versa, useless waste of material may be involved or a new design may lack in safety.

It is, therefore, of considerable interest, in reviewing the new tendencies in dam design methods, to observe the attempts which have lately been made to establish new stress criteria. Two schools of thought may here be traced, referring respectively to (*a*) the height of the dam, and (*b*) the specific conditions which produce and affect the failure of the material—as distinct from those causing elastic deformation alone.

The first school assumes that in addition to stresses we must also take into account the height; or, in other words, that the stress criteria must be a function of the height factor. There are two standpoints which may alternatively be adopted in substantiating this solution: the scholastic approach and the "natural" foundation.

In older times it was commonly believed that greater risks of contingencies call for larger margins of safety ("factor of ignorance") and as it was self-evident that the disastrous consequences of dam failures increased with the depth of the water impounded in the reservoir, opinions had from time to time been expressed to the effect that some additional factor should preferably be introduced into the design of very high dams. This, however, was by no means a generally accepted postulate as, on the average—since the middle-third rule and the maximum-stress criterion had to be both satisfied in combination with each other—the maximum stress became usually greater in high dams. Still, the principle of an additional safety margin depending on the height of the dam has occasionally been put forward; for instance, it tacitly appears in the official circular of the Italian Government, which prescribes more severe uplift assumptions as the maximum height of the dam increases.

This circular was issued on October 1, 1931. The scale for uplift assumptions was as follows:—

Height of dam.	Values of uplift factor of		
	Entirely sound rock foundation, possessing no defects whatever.	Rock foundation of fair quality, with very few minor defects.	Average quality of rock in the foundations, its weak spots being improved by means of injections.
Under 25 m...	0	½	1
Under 50 m...	½	¾	1
Under 75 m...	¾	1	1
Above 75 m...	1	1	1

For intermediate heights, the tabulated values are to be interpolated.

The modern approach is, however, quite different; in this case, instead of a conventional interpretation, the effect of the height of the dam is visualised as a physical factor creating or aggravating the influences of various secondary causes of stress in the structure—such, for instance, as foundation settlements, three-dimensional effects, volumetric alterations due to the intervention of various physical agencies, &c.—and intensifying, on the other hand, the importance of the difference between Sazilly's diagram and the non-linear stress analysis (for the lower part of the dam).

In its simplest form this principle is introduced into the code of the state of Arizona, which admits rectilinear stress computation methods on standard lines for dams up to 150ft in height, but prescribes the use of more advanced solutions for greater heights. While such a criterion is eminently practical, it may be objected that it creates rather too rigid a demarcation line. This objection could, of course, be easily removed by the introduction of some type of sliding scale. But the suggestion may also be made that the secondary effects mentioned above may possibly be more affected by the ratio which the height bears to the length of the dam than by the absolute value of the height taken alone and that still closer relationship might, very probably, be found with the rate of change of the height (measured along the axis of the dam). The importance of re-entrant angles and so forth would be thus brought out.

These suggestions are, however, by no means to be interpreted as detracting in any way from the merits of the new additional criterion which, it is hoped, will augment the precision, significance and value of the stress analysis in general. But the more important question is whether the stress, as such, should still continue to be used as a criterion when and if the standard, old-established solutions are replaced by new methods supposed to give a more close approximation to the true physical facts. Here appears to lie the crux of the whole problem.

Stress has been the deity which we have been worshipping for almost one hundred years, since Sazilly's time, but iconoclastic heresies have already begun to raise their voices, tending as they do towards upsetting this long established cult.

It will, of course, be clear that Sazilly's trapezoidal diagram forms a single entity with Rankine's middle-third rule, and the usually accepted compressive stress limits; mutual compensation of errors being the principle upon which these three constituent

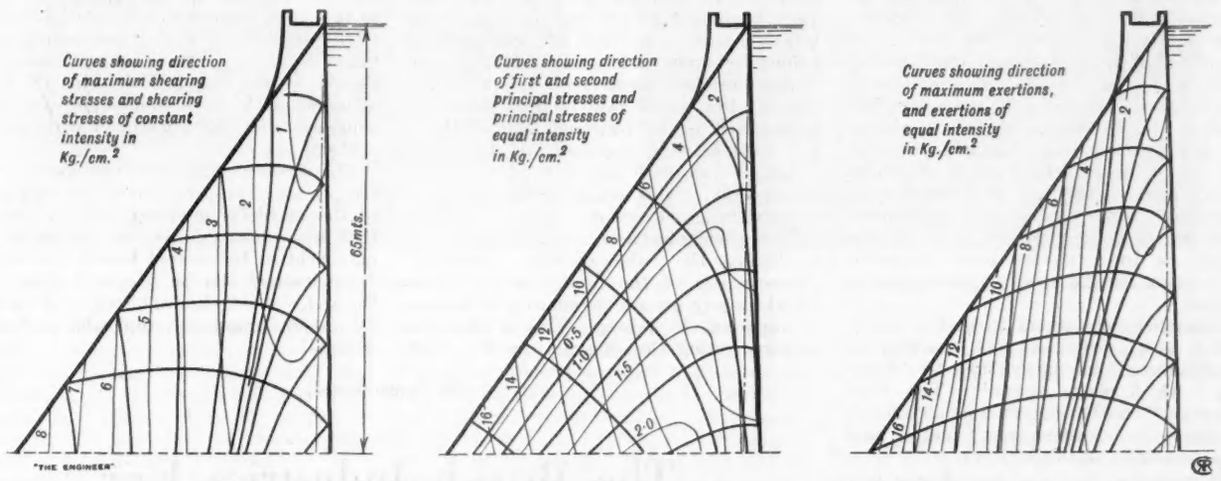

Curves showing direction of maximum shearing stresses and shearing stresses of constant intensity in Kg./cm.²
65mts.
Curves showing direction of first and second principal stresses and principal stresses of equal intensity in Kg./cm.²
Curves showing direction of maximum exertions, and exertions of equal intensity in Kg./cm.²
"THE ENGINEER"

FIG. 10—STRESS ANALYSIS FOR SCHWARZENBACH DAM

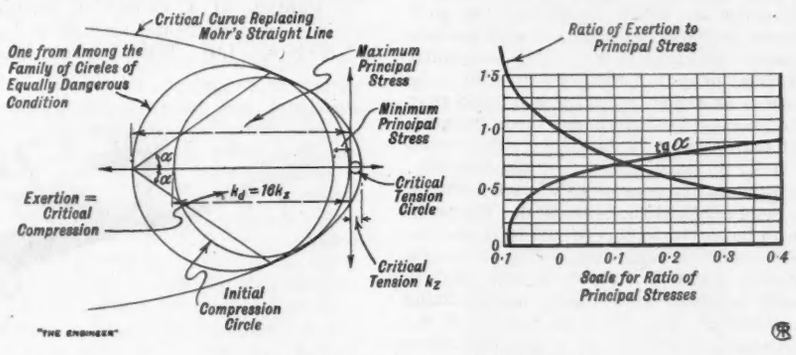


FIG. 11—COMPUTATION OF "EXERTIONS"

elements of the whole system work in conjunction with each other. Improvements, therefore, whatever they may be, must be comprehensive; that is to say, they must jointly affect all the three parts of the combined self-contained criterion.

That tensile stresses and higher compressive limits may eventually be allowed, when the more advanced stress-calculation methods are used as a standard practice of dam design is obvious, and does not call for any particular remark or explanation. But what should be particularly stressed is the fact that altering the stress limits alone will not be enough; for it is a matter of common knowledge that the stress, however high it may eventually rise, will not suffice to predict the imminence of the rupture of material.

Whichever of the various theories of failure we may accept as true, it is, nevertheless, certain that the critical conditions are determined by (or, to be more precise, occur under) a certain combination of normal and shearing stresses; and it would, therefore, be childish to turn our backs upon the fact. Instead of the stress we must, consequently, introduce into the calculation of a dam—should conventional methods be excluded—a new value, viz., a certain function of the normal and shearing stresses, multiplied respectively by appropriate co-efficients and resolved in such a manner as to give the most dangerous combination for the most probable plane of rupture.

Kammuller, who seems to be the author of the idea, describes this function as "Anstrengung," in contradiction to "Spannung," which means stress.[14] The word "Exertion" can be suggested as an English equivalent to "Anstrengung," and is used in the remainder of this article.

We take the liberty of reproducing here three diagrams (see Fig. 10) borrowed from Kammuller's most interesting little book on the subject, to which we have already referred frequently in these pages. The first two diagrams differ from those published by other authors in that only curvilinear stress corrections are taken into account in preparing them, in addition to the linear intensities usually considered in such cases; the third diagram is, however, an entirely original computation, intended to give a graphical description of the principle of "exertions."

In order the better to explain the path followed in this investigation, it may perhaps be more convenient to begin with an explicit statement of its intended object. The state of stress in a point of an elastic solid may be conceived as defined by three independent parameters; for instance, the stresses on three different planes, or, alternatively, two principal stresses and the angle between the main axis and the horizontal. The problem to be solved in this case is to transcribe these complex conditions, using one single variable, selected in such a way that it should represent numerically and determine quantitatively the potential danger of the occurrence of failure, in every individual point of the profile.

Obviously, a solution of that kind cannot be arrived at without first agreeing as to which one from among the many alternative theories of failure should be selected to serve as a basis for this computation. Kammuller uses for that purpose an amended type of Mohr's graphical criterion, the straight lines of the latter being replaced by a curve (see Fig. 11), which is drawn as a tangent to two circles, representing, respectively, equally dangerous conditions under pure tension and pure compression. The ratio of the diameters of these circles being taken as one to sixteen.

So far, it will be observed, the figure is an abstract computation possessing no specific scale. We next proceed to draw in it a number of circles, all of them tangential to the critical curve and representing, therefore, conditions of stress equivalent to those of the two initial circles.[15] A series of such circles forms, consequently, a group, or family, of cases which all, in regard to the potential occurrence of failure represent equally dangerous conditions; every individual circle being, however, characterised by a certain specific ratio of the two principal stresses, and every family of circles being, in turn, typified by the scale, which is supposed to be eventually used when interpreting numerically the abstract computation shown in this diagram. Which means to say that the characteristic values for every family of equivalent conditions are the diameters of the two initial circles; but, as the ratio of these diameters is assumed to be constant, one of them, for instance the diameter of the compression circle, will suffice to describe the group fully. This diameter is, therefore, referred to as "exertion."

The problem has now been reduced to that of finding the value of the "exertion" characteristic of the family of conditions to which any given combination of stresses is supposed to belong. This is done as follows: using the diagram in Fig. 9(*a*), we prepare a chart (see Fig. 11), in which the ratios of the principal stresses are plotted as abscissæ, whilst the corresponding ratios of the maximum principal stresses to the "exertions," are used as ordinates. This diagram can then be employed to calculate the "exertion" corresponding to any given maximum principal stress, depending upon the ratio of the maximum to the minimum stresses in the same point. In addition, the chart includes also another curve which represents the tangent of the angle α between the virtual plane of rupture and the main axis. This curve is used for drawing the envelopes of the probable rupture planes in the profile of the dam.

The ingenuity of the computation is rather remarkable; it must, nevertheless, be realised that in the form it is presented, the solution is not devoid of a certain fallacy. Kammuller's mistake originates in the fact that he applies the new criterion to the stress intensities calculated according to the Sazilly-Levy theory, no account being taken by him of the elastic disturbances caused by the foundation. This is almost as wrong as the more common *lapsus*, which combines new stress methods with archaic criteria.

The whole discussion is, however, instructive, as a vivid illustration of the complexity of the problems involved, and as showing that stress analysis is by no means the only field to be covered before the Sazilly-Levy method can be relegated entirely to the archives of technical history and replaced by a new, practically applicable system of design.

(To be continued)

[14] The principle has been used in designing the Schwarzenbach dam.

[15] For sake of simplicity, one of these circles only is shown in the diagram, Fig. 11.

The British Industries Fair

No. III—*(Continued from page 397, May 9th)*

IN this article we continue our account of the British Industries Fair with short descriptions of a further selection of exhibits shown in the Engineering and Electrical groups at Castle Bromwich. The Fair closes to-day, May 16th, but we hope to continue our account of the exhibits in our next issue.

Accles and Shelvoke, Ltd

In addition to a variety of repetition machined components and assemblies, Accles and Shelvoke, Ltd., Talford Street Works, Aston, Birmingham, 6, is manufacturing a useful quick action vice designed particularly for use in production machining. This vice is light and easy to operate, and can be set to grip components consistently to any predetermined limit within its capacity, irrespective of the load applied on the handle by the operator. Its jaws, which are 3½in wide, and have a depth of 1 1/16in, can be set to accommodate components up to 2in wide.

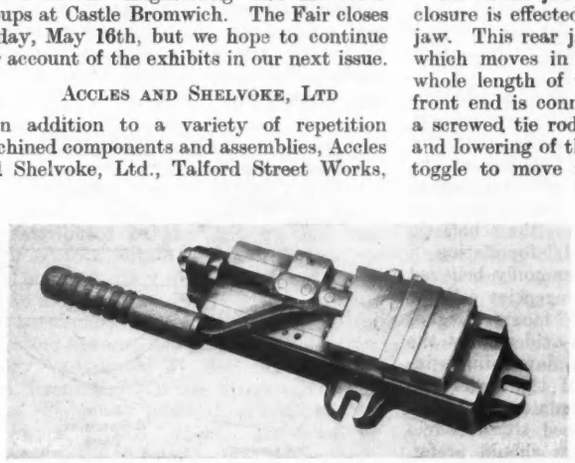


FIG. 15—MACHINE VICE—ACCLES AND SHELVOKE

The front jaw of the vice is fixed and closure is effected by movement of the rear jaw. This rear jaw is integral with a slide, which moves in ways machined along the whole length of the vice body, and at the front end is connected to the fixed jaw by a screwed tie rod and toggle link. Raising and lowering of the vice handle actuates the toggle to move the rear jaw, through its slide, for a distance of ⅜in in respect to the fixed jaw. The distance between the end of the slide and the toggle, and thus between the fixed and moving jaws, is adjusted by means of two nuts on the tie bar. The vice handle can be easily set for right hand, left hand or vertical movement by the removal of a screw in the fixed jaw bridge. In the photograph we reproduce in Fig. 15 the vice handle is arranged for right hand sideways movement for closing or opening the jaws.

R. H. Neal and Company, Ltd.

Included in the range of cranes from 9 cwt to 2 tons capacity, which are being demonstrated by R. H. Neal and Company, Ltd.,

Plant House, Ealing, London, W.5, is to be seen the useful little three-wheel runabout illustrated in Fig. 16. This machine is designed to lift and transport weights up to ½ ton. The drive and steering is effected through the single rear wheel and this arrangement gives the crane a high degree of manœuvrability for working in restricted spaces. It is made in two models, the standard and the "lorry loading."

FIG. 16—RUNABOUT CRANE—NEAL

The standard model is intended for work which involves passing through narrow spaces, and has an overall width of 4ft 6in, with a jib radius of 6ft 3in. The "lorry loading" model is used for yard work and stacking purposes, and has an overall width of 5ft 3in, with a jib radius of 8ft 3in. Both models have a travelling speed of 2¼ m.p.h. and can turn within a circle just under 12ft diameter.

The crane is driven by an air cooled J.A.P. petrol engine, developing 5–6 b.h.p. Primary transmission is effected by bush roller chains to countershaft. The forward and reverse motions are transmitted through cone clutches and a reversing bevel gear unit. Traction drive is taken through a vertical shaft, running through the castor pivot, bevel and spur gears to the rear wheel, which is mounted on a live axle. The jib is raised or lowered by a hand-operated rack and pinion derrick gear and it can be locked rigidly in any desired position. In the hoisting unit a specially designed free-wheel connects the rope drum and the hoist brake so that the load can be raised without releasing the brake. When the clutch is released, the load is held until lowered by release of the brake. This hoisting brake effect is directly proportional to the movement of a hand lever and can be set to lower a load steadily at any required speed.

The controls of the crane are simply arranged and light to operate. A steering wheel and derricking handle are conveniently arranged in front of the driver; on his left are two levers for hoisting and lowering, and a pedal by his right foot operates the forward and reverse travelling clutches.

JOSHUA BIGWOOD AND SON, LTD.

The selection of machine tools made and exhibited by Joshua Bigwood and Son, Ltd., of Wolverhampton, includes a variable angle roll tube and bar straightener. The company is now making four main types of these machines. The first is a high speed straightening machine, which has two fixed-angle driving rolls and three or five variable-angle adjustable idle rolls. A second machine, illustrated in Fig. 17, is of similar design, but has variable-angle driving rolls and is more suited to the straightening of tubes. As the angle of all the rolls in this machine can be varied, the rolls can be brought into line contact with the work rather than on a pair of point contacts, irrespective of the diameter of the work.

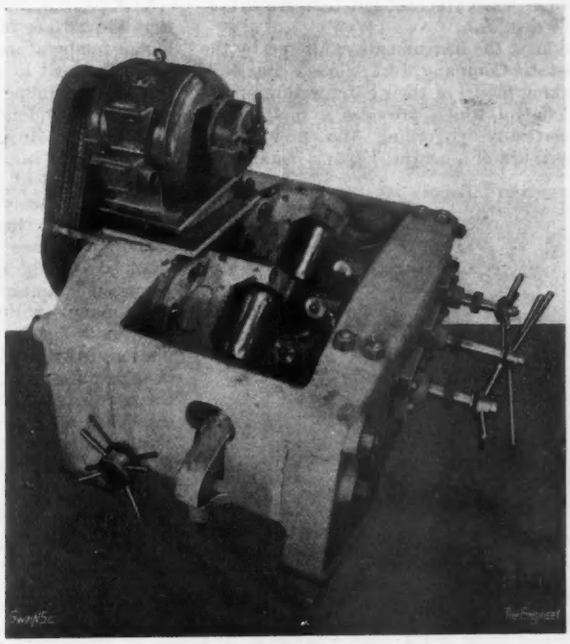


FIG. 17—BAR AND TUBE STRAIGHTENING MACHINE—BIGWOOD

In a third type of machine the centres of the variable-angle driving rolls are adjustable in relation to the centre line of the machine and thus in relation to the centrally dispersed idle roll. This method of adjustment enables the rolls to be set to produce a line contact on the bar or tubes being straightened on the length of bend round the central idle roll. This central roll effects the major degree of straightening in this type of machine and the arrangement makes the machine capable of dealing with harder degrees of metal than the two previously described. The driving roll assemblies are self-contained units with separate flange-mounted motors. This form of drive is stated to give a certain economy in power, as the rolls are built to accommodate themselves more readily to the relative speeds imposed by differing contacts with the work.

The fourth type of straightening machine has the rolls disposed vertically rather than horizontally. All the rolls are driven and have a large and varied degree of adjustment which enables the machine to function as a straightener for improved end-of-bar straightening. When used for hot work the machine exercises considerable size correction effect and improvement in circular form.

The firm is also exhibiting the small shape and section straightening machine. It is designed for straightening angles up to 1in and a variety of standard window frame sections, at speeds up to 300ft per minute. The range of machines extends up to straighteners for 130 lb per yard rails and 24in by 7½in rolled steel joists. A range of horizontal press type straightening and bending machines made by the firm is designed to handle bars, billets and sections up to 12in by 12in mild steel billets.

RHEOSTATIC COMPANY, LTD.

The urgent need for fuel economy gives added topical interest to any device designed to regulate the heat input to central heating systems in accordance with prevailing weather conditions. It is evident that changes in outside temperature, for instance, must always affect the heat input required to maintain a constant temperature inside a building and that the heat loss through the walls is governed by the existing temperature

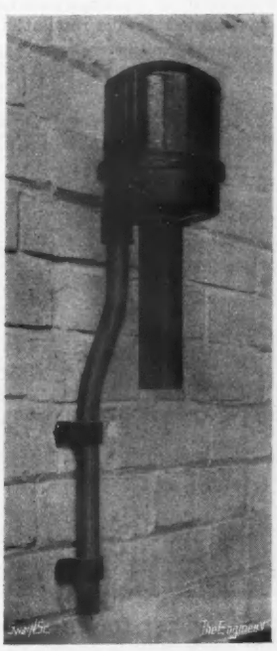


FIG. 18—TEMPERATURE COMPENSATOR. OUTDOOR PILOT—RHEOSTATIC

difference. For example, if the internal temperature for comfort is required to be 65 deg. Fah., then the heat input will need to be much greater when it is freezing outside than when the ambient temperature is, say, 60 deg. Fah.

Amongst the instruments exhibited by the Rheostatic Company, Ltd., Slough, Bucks, is a working model of their Satchwell temperature control which provides a method for automatically governing the flow water temperature of a central heating installation

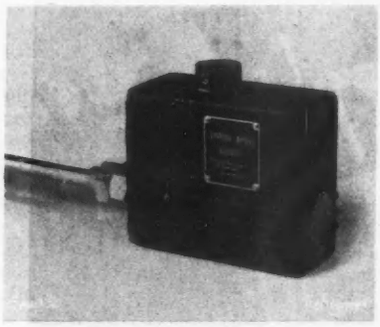


FIG. 19—REGULATOR THERMOSTAT—RHEOSTATIC

in such a way as to compensate for changes in the ambient conditions. The equipment consists of three units: the pilot (Fig. 18), which is mounted on an exterior wall, where it is in a position to respond to weather changes; the regulator thermostat (Fig. 19), which is inserted in the flow main of the heating system; and the calibrator box (Fig. 20), which is mounted on an internal wall and provides a means of adjusting the circuit to suit individual conditions and requirements.

In operation, the pilot selects a boiler temperature which is suitable for balancing the prevailing heat losses and so maintaining a constant indoor temperature. The selected boiler temperature is communicated electrically from the pilot to the regulator, which

FIG. 20—CALIBRATOR BOX FOR TEMPERATURE COMPENSATION—RHEOSTATIC

automatically adjusts itself to control at that temperature until a further change in the external conditions brings about a new regulator setting. Suitably proportioned resistors are contained in the calibrator box, so that the control circuit can be adjusted to match the response characteristics of the compensator with the thermal properties of the building. The calibrator also incorporates a day-night switch to allow the boiler to be turned down, when desired, to a suitable night temperature. Alternatively, a time-switch can be used to effect the same change automatically at any pre-determined time.

The pilot embodies a heater element, so that the surface of the casing is always at a higher temperature than the surrounding air. Since the heat loss from the pilot is subject to the same influences as heat loss from the walls, it is evident that any changes in the prevailing conditions—sun, wind, or rain—will have the same effect upon the pilot as upon the wall of the building. Thus, wind increases the heat loss from the building and, to the same extent, from the pilot which, thereupon, causes the regulator setting to be changed and the flow water temperature to be raised maintaining the required temperature condition within the building. Evaporation has a similar effect upon the wall, the pilot and the heating system. In short, any change in the elements that causes a change in the heat loss from the building is detected by the pilot and results in a compensatory change in the regulator and in the heat flow of the main installation.

BIRLEC, LTD.

Early attempts to use low-frequency heating in channel type induction furnaces for light alloys resulted in failure through the rapid building-up of slag particles in the channels. To clear these stoppages it was necessary to dismantle the furnace lining. An important characteristic of the induction melting furnace exhibited by Birlec, Ltd., Birmingham, is that the channels are arranged so that the narrow portion in which the heat is mainly generated (and where slag accumulation would be most detrimental) can be cleared instantly by poking a steel rod through from top to bottom while the furnace is in operation and without the necessity for any dismantling.

A general impression of the 25-kW bale-out Birlec-Tama induction melting furnace is given in Fig. 21. The arrangement comprises a refractory-lined bath containing the major portion of the molten metal. From the bottom of this bath two vertical channels extend downwards and are joined by a third transverse channel of considerably larger dimensions. The horizontal channels have a clean-out plug at one end, as shown in the illustration, so that the slag can be cleaned out easily at infrequent intervals as necessary.

In the loop formed by the bath of metal and by the vertical and horizontal channels beneath it a laminated iron coil is arranged, surrounded by an air-cooled inductor coil, a portion of which can be seen immediately below the main rectangular casing in the accompanying illustration. The core is provided with a laminated yoke, making a complete magnetic circuit, so that the assembly acts as a transformer with the inductor coil serving as the primary and the loop of molten metal as the secondary winding. The heat generated in the metal by induction is accompanied by a continuous stirring action, which helps to achieve homogeneous composition and uniform temperature throughout the bath. Through this action heat is conveyed rapidly to cold metal, as it is charged into the bath, but as with all furnaces of this kind, some molten metal must be left in the bath at all times to complete the secondary circuit; that is to say, the furnace cannot be charged with cold metal only.

The 25-kW furnace exhibited (Fig. 21) is a relatively small unit with a holding capacity of 75 lb per hour and is designed for supplying die casting requirements.

Larger furnaces are made with multiple inductor coils and melting channels, and range in capacity up to 6000 lb with a corresponding melting rate of 1 ton of aluminium per hour.

Another Birlec exhibit is a high-frequency hardening unit designed specifically for the automatic surface hardening of small steel spindles at the rate of 600 per hour. The spindles in question are of a medium-carbon steel and are about 3¼in long by ¼in diameter. Hardening is required to a depth of 0·02in over the wearing surface, which occupies a length of about 1⅞in.

High-frequency power is derived from a mains driven valve oscillator unit having a nominal output of approximately 5 kW at a frequency of about 800 kc/s. A single air-cooled oscillator valve is used, fed with high-voltage d.c. from a three-phase bank of mercury vapour rectifier tubes supplied by the main transformer. The oscillator is designed to be suitable for a wide range of induction heating operations and is provided with a simple manual adjustment for matching the impedance of the load to that of the

FIG. 21—25KW L.F. INDUCTION MELTING FURNACE—BIRLEC

valve for maximum efficiency on different kinds of work.

The inductor and work-handling units are combined in a compact structure, fully enclosed and mounted against the front of the oscillator cubicle. The inductor itself is of the "concentrator" or transformer type, enabling the full power of the oscillator to be applied, through an inductor coil of efficient dimensions, to the intense heating of a small localised area of the work piece. By moving the latter progressively through the inductor aperture, therefore, this concentrated heating effect is applied uniformly, though progressively, over the full area which it is desired to harden. To harden the same area simultaneously all over would require a generator of very much higher power and greater cost.

The spindles to be hardened are placed by hand in a magazine at the top of the machine and are fed by gravity into a horizontal guide leading to the aperture of the inductor. From this point the entire hardening process, including control of power, quenching and ejection is continous and automatic.

This machine provides a good example of the flexibility with which high-frequency induction heating can be applied to a precise heat-treatment specification for a particular product. Moreover, the machine illustrates the development of heat-treatment processes on machine tool lines.

(To be continued)

American Hydraulic Engineering

In the flood of engineering works to be begun or carried out in the United States during 1947 a large number are hydraulic projects, which may be generally classified as follows:—First, new or enlarged and improved water supply for domestic use and industrial purposes, including hydro-electric plants, with their dams and pipe lines or conduits; secondly, control of flood waters and protection against damage by floods; thirdly, stoppage of pollution of water by sewage and industrial wastes, including the purification treatment of polluted water and the recovery or salvage of useful chemicals or other matters hitherto lost in the polluted water; fourthly, the improvement of inland navigation. Two Government Departments handle a large proportion of these hydraulic projects. The Bureau of Reclamation deals largely with irrigation works, but also with flood control and power development. The Corps of Engineers, U.S. Army, deals with flood control, bank protection and improvements to inland navigation, but many of its great dams serve also to store water for power development. Very many of these hydraulic projects are of a multiple-purpose character, in which it is necessary to balance a number of conflicting considerations. The numerous dams represent practically every type of design and construction. Concrete dams include gravity, arch, multiple arch and hollow or slab and buttress types. Embankment dams may be of earth or rock. Locks or power-houses may be adjuncts of the dams. Tunnels may be required either as conduits or spillways. It is interesting to note that in two of these important activities the conditions get worse in spite of the improvement works. This is the case in regard to floods and pollution. Lines of research in hydraulic engineering include methods of lining irrigation canals to stop or reduce losses by seepage and the travel of silt and sediment in rivers and canals. Such research includes experiments on full-size and model scales.

Stress Concentration and Fatigue Failures*

By PROFESSOR S. TIMOSHENKO†

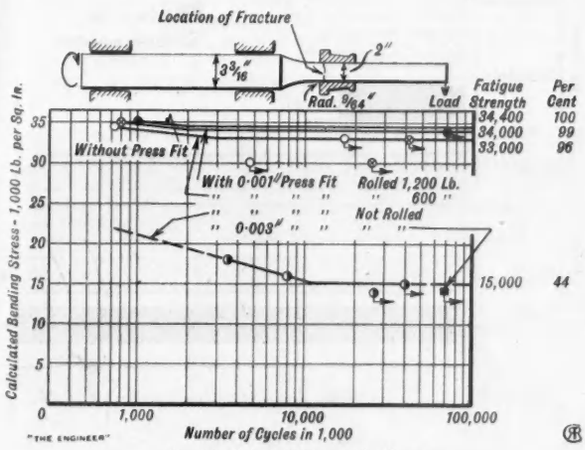
No. II—(*Continued from page 399, May 9th*)

The preliminary experiments in the study of surface rolling were made on 2in diameter shafts with pressed-on hubs. The specimens with hubs pressed on showed great weakness in fatigue tests. But by cold rolling the press fits the weakening effect of the hub was practically eliminated. Fig. 7 shows the results of these tests. The presence of the hub reduces the fatigue strength of specimens to less than half of their initial strength, and the proper surface rolling restores the initial strength.

Figs. 8 and 9 show the experiments with 2in diameter models of locomotive axles. Tests were made with three different kinds of material, and in all cases the strength was greatly improved by surface rolling.

After these preliminary experiments, tests of full-size locomotive axles and some other locomotive parts were started. For these tests special large-size fatigue-testing machines were designed, one of which is shown in Fig. 12. The middle portion of the machine represents a rotor, to each end of which an axle is bolted and tested as a cantilever rotating specimen.

The necessary forces applied at the ends of cantilevers are produced by special calibrated helical springs. In Fig. 10 one of the full-size specimens is shown. In Fig. 11 the fatigue test results for such specimens are shown. In the case of the unrolled surface, the endurance limit, calculated from the elementary beam formula, is about 11,000 lb per square inch. In the case of rolled specimens, no failures occurred, and the endur-



Steel to S.A.E. 1045 specification.

FIG. 7—STEEL AXLES TESTED WITHOUT LOAD ON PRESSED-ON HUB

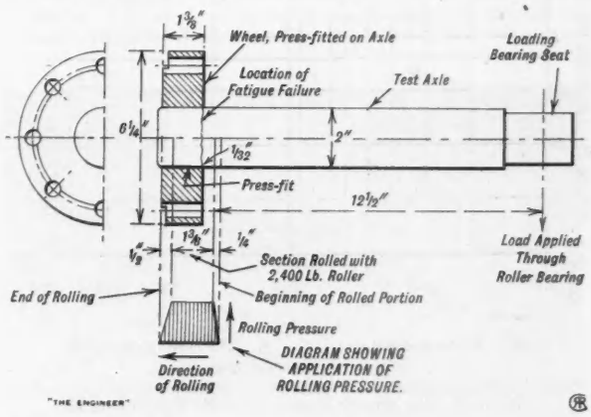
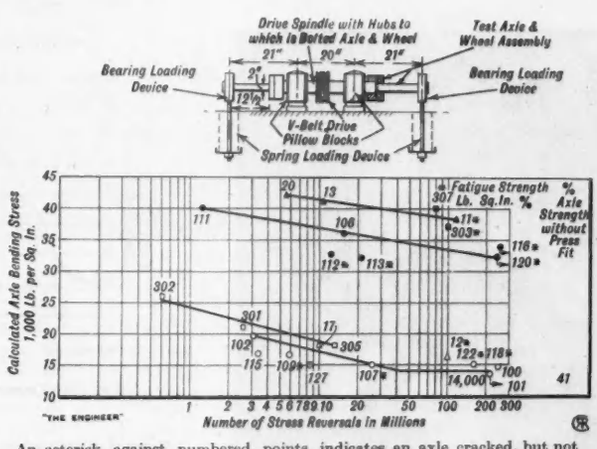


FIG. 9—DIMENSIONS OF TEST AXLE AND PRESS FITTED WHEEL



An asterisk against numbered points indicates an axle cracked, but not broken off.

○ Steel Specification S.A.E. 1045 N. and D.; no surface roll pressure.

● Steel Specification S.A.E. 1045 N. and D.; surface roll pressure, 2400 lb per square inch.

△ 2·75 per cent nickel steel; quenched and tempered; no surface roll pressure.

▲ 2·75 per cent nickel steel; quenched and tempered; surface roll pressure, 2400 lb per square inch.

□ "Amola" steel; quenched and tempered; no surface roll pressure.

■ "Amola" steel; quenched and tempered; surface roll pressure, 2400 lb per square inch.

Points with arrows indicate axles still in test.

FIG. 8—FATIGUE TESTS ON SPECIMENS SUBJECTED TO BENDING

Surfaces in fitted portion were tested (1) cold-rolled and (2) without cold rolling.

FIG. 10—9½IN SHAFT WITH PRESSED-ON ROTOR

* Institution of Mechanical Engineers, April 25th, James Watt Lecture. Abstract.

† Professor Emeritus of Theoretical and Applied Mechanics, Stanford University, California, U.S.A.

ance limit must be higher than 22,000 lb per square inch.

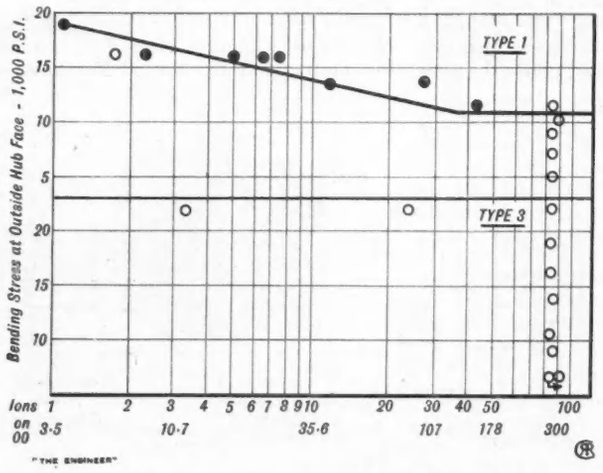
The results obtained with full-size specimens showed that the effect of cold rolling depends principally on the roller pressure and on the depth of penetration of cold work. For locomotive axles roller pressures above 20,000 lb were used and the cold-worked layer was about ¼in thick. With surface rolling any desired surface finish can be produced by changing such factors as roller shape, roller pressure and feed. It seems that fatigue resistance of rolled members is not dependent upon the degree of smoothness of the surface finish.

The laboratory test results were so promising that some railways of the United States introduced as their requirement the surface rolling of axles and other parts of locomotives, such as piston-rods, connecting-rods, crank pins and tyres.§

§ See paper, "Stressing Axles and Other Railroad Equipment by Cold Rolling," by O. J. Horger, presented at the annual meeting of the American Society for Metals, February, 1946.

To produce a sufficient thickness layer of cold-worked material, considerable roller pressure and heavy equipment for the surface rolling of large-diameter axles was used. In the case of small-diameter shafts and light machine parts, a thin layer of cold-worked metal already shows a considerable improvement in fatigue strength. A simple way of producing such surface cold work is shot-peening. This process has found an extensive application in recent years, especially in the automobile industry. It has proved very efficient and economical in cases where shot-peening replaces the surface machining of members. Fig. 14 gives the fatigue strength corresponding to various intensities of shot-peening. It seems that there is a limit beyond which no further improvement in strength can be obtained. Fig. 13 shows what improvement in fatigue strength was accomplished by shot-peening of automobile rear axles. The surface of the axles is not machined, and there is a surface layer of material decarburised during heat treatment. The shot-peening much improves the fatigue strength of that layer.

The examples of stress analysis and fatigue failures already discussed illustrate how important the study of stresses is in modern machine design. They show also the increasing importance of experimental stress analysis in design. The photo-elastic method, the stress-coat method, and the resistance-wire strain gauges are at present widely used in machine industry. The combination of a refined stress analysis with properly planned fatigue tests has greatly contributed to the improvement of machine design and reduced considerably the number of fatigue failures in service.


Bending Stress at Outside Hub Face - 1,000 P.S.I.
TYPE 1
TYPE 3
Ions 1 2 3 4 5 6 7 8 9 10 20 30 40 50 100
on 3·5 10·7 35·6 107 178 300
"THE ENGINEER"
● Broke in wheel seat. ○ Cracked in wheel seat.
○→ Not cracked in wheel seat.

Since no rolled axles of type 3 broke off, no endurance limit curve can be drawn, but the stress is higher than 22,000 lb per square inch.

FIG 11—ENDURANCE TESTS FOR LOCOMOTIVE AXLES

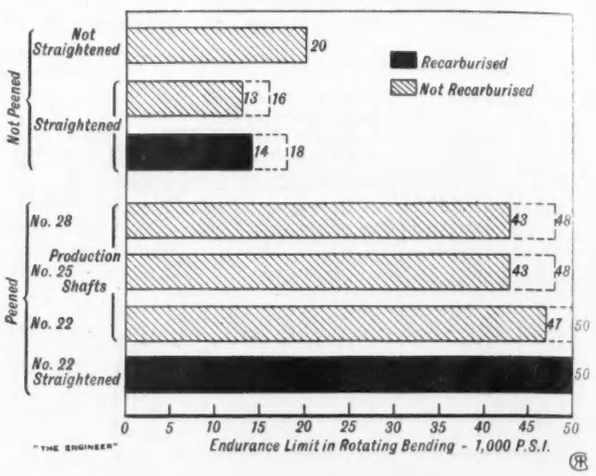


FIG 13—FATIGUE STRENGTH OF AUTOMOBILE REAR AXLES

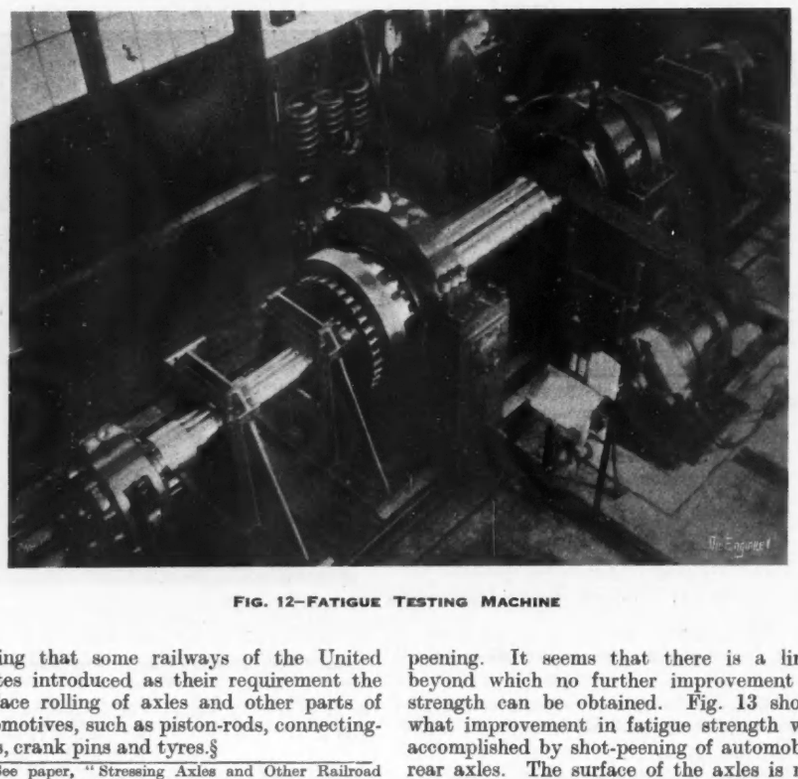


FIG. 12—FATIGUE TESTING MACHINE

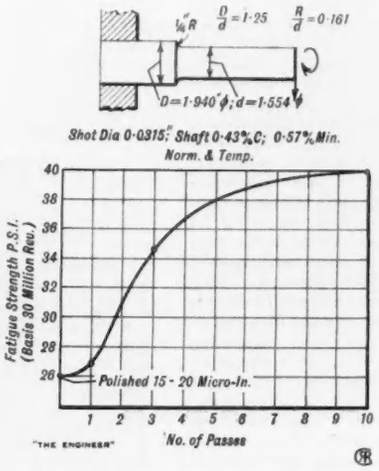

½"R D/d = 1·25 R/d = 0·161
D = 1·940" ϕ; d = 1·554
Shot Dia 0·0315" Shaft 0·43% C; 0·57% Mn.
Norm. & Temp.
Fatigue Strength P.S.I. (Basis 30 Million Rev.)
Polished 15 - 20 Micro-In.
"THE ENGINEER"
No. of Passes

FIG. 14—EFFECT OF SHOT-PEENING

NEW TOWN AT AYCLIFFE.—The Minister of Town and Country Planning has announced his decision to make an order under the New Towns Act, 1946, designating Aycliffe, County Durham, as the site for a new town. Aycliffe is designed to house 10,000 people, mainly workers employed on Aycliffe Trading Estate, which is being developed on the site of the former Royal Ordnance Factory. The site, covering an area of about 880 acres, is at present agricultural land bordered on the east by the Great North Road, on the south by the Shildon-Newport railway line, and on the north-west by Woodham Burn.

Suburban Electrification on the Central Argentine Railway

FOLLOWING upon the publication in our pages last August of an article entitled "An Engineer Looks at Argentina," the Central Argentine Railway has supplied the following additional material, bringing the information about that country right up to date.

The first branch of the Central Argentine Railway's suburban services in the Buenos Aires area to be electrified was from Retiro to Tigre C., a distance of 28 km., which was inaugurated on August 25, 1916. For the supply of power for this service a power station of 12,000 kW capacity was built at Canal San Fernando, on the west bank of the Lujan River, from which the circulating and boiler feed water was pumped. Eight Babcock and Wilcox marine type boilers, each of 20,000 lb per hour, were installed for supplying steam to four 3000-kW Parsons turbo-alternators, which generated three-phase current at 2500 V, this being stepped up to 20,000 V for distribution to sub-stations situated at strategic points of the line. The three traction sub-stations were all equipped with three 1000-kW rotary converters and associated switchgear supplied by the British Thomson-Houston Company, Ltd., for supplying d.c. current to the third rail at 800/825 V. The high and low-tension cables were manufactured and laid by W. T. Henley's Telegraph Works, Ltd. The rolling stock was of the multiple-unit type and consisted of the two-saloon type of coach with centre and end vestibules as follows :—

Motor Coaches.—First class, forty-seven ; second class, twenty.

Trailer Coaches.—First class, thirty-two second class, eighteen.

These coaches were all fitted with the Thomson-Houston Company's electrical equipments.

In January, 1929, the Argentine Government authorised the extension of the electrified services to the Retiro-Tigre R. and Retiro-J. L. Suarez lines, the latter forming part of the main line to Rosario, Cordoba and the North. The two lines in question represent some 40 km of double track, thus making a total of approximately 68 route kilometres for the whole electrified suburban system. To meet the additional loading the power station capacity was increased to 34,500 kW by the installation of three 7500-kW Parsons turbo-alternators and four 50,000 lb per hour Babcock and Wilcox marine type water-tube boilers. The alternators supplied current at 5000 V to Metropolitan-Vickers step-up transformers feeding the 20,000-V high-tension network. For the extensions some 95 km of high-tension cables were supplied and laid by Callender's Cable and Construction Company, Ltd. Five new supervisory controlled sub-stations were erected, three for the extensions to the Tigre R. and J. L. Suarez lines and two to meet the increased loading on the original Tigre C. line. In addition, the capacity of each of the three original sub-stations was increased by a 2000-kW rotary converter, bringing the grand total of sub-station conversion plant for traction up to 41,000 kW. All the sub-station conversion plant and equipment and switchgear for the extensions was supplied and erected by Metropolitan-Vickers, Ltd. The equipment of the supervisory control room situated at Olivos sub-station—the centre of gravity of the system—was manufactured by the Automatic Telephone Manufacturing Company, Ltd. It can be added that the supervisory control system in question was the first of its kind to be installed in the Argentine Republic. The d.c. feeder and track cables were also supplied and and laid by Callender's Cable and Construction Company, Ltd.

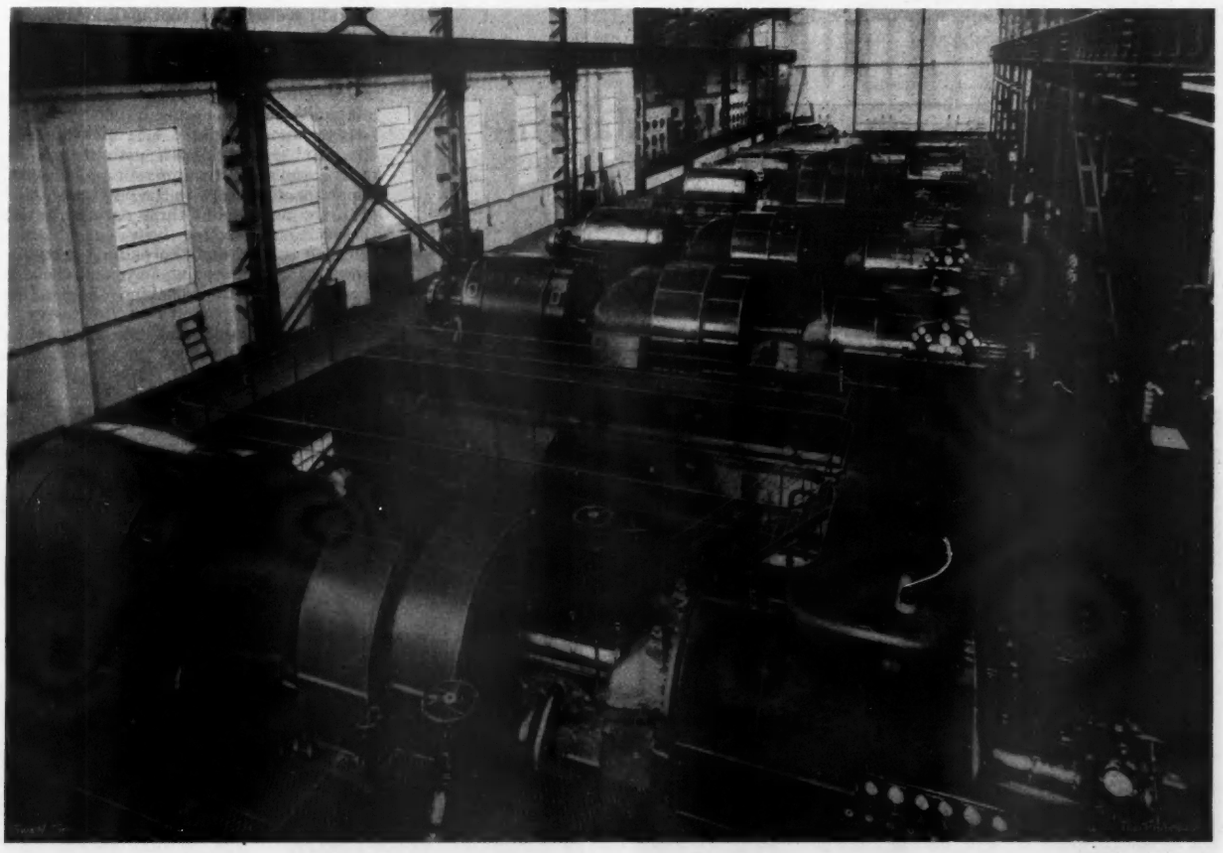
The rolling stock was increased to a total of 370 coaches in all, 180 of these being of the latest semi-steel construction. The division of coaches was as follows :—

Motor Coaches.—First class, 105 ; second class, 85.

Trailer Coaches.—First class, 99 ; second class, 81.

As distinct from the motor coaches of the original electrification, which were provided with two 250 h.p. motors mounted on the same bogie, the slightly heavier and longer stock ordered for the extension of the services was powered by two 310 h.p. traction motors, the complete equipment for both motor and trailer coaches being supplied by the Metropolitan-Vickers Electrical Export Company, Ltd.

Just prior to the outbreak of the 1939-1945 war, arrangements were made to renew the original boiler and turbine plant which had been in service since 1916, catering, at the same time, for increased loading in the near future. Work was commenced in 1939 on the installation of one Parsons 7500-kW turbo-alternator and two Babcock and Wilcox 50,000 lb per hour boilers, which had to be installed before any of the original plant could be withdrawn. Upon the completion of this stage of the work two of the original 3000-kW turbo-alternator sets were dismantled. Towards the end of 1941 the erection of the third 50,000 lb per hour boiler and also the second 7500-kW turbo-alternator was commenced, the foundations for the latter having been built on the site of the two original 3000-kW turbo-alternators that had been removed. As a final step the two remaining 3000-kW turbo-alternators were dismantled, leaving the site available for future extensions. In the photograph of Canal San Fernando power station, reproduced herewith, the first turbo-alternator to be installed under



CANAL SAN FERNANDO POWER STATION

the renewals programme is seen in the immediate foreground, whilst the second set is that furthest away in the background, where the space for a future machine can also be seen. By these works the power station capacity was increased from 34,500 kW to 37,500 kW.

Whilst the turbo-alternator capacity installed on the renewals programme had been increased from 12,000 kW to 15,000 kW on continuous maximum rating to meet the peak demands of a constantly increasing traction load, the boiler capacity replacement was smaller by 10,000 lb per hour—three 50,000 lb per hour boilers replacing eight 20,000 lb per hour units. This apparent loss of steam capacity was more than compensated for by an increase in the steam generation pressure from 210 lb to 275 lb per square inch at the main boiler stop valve and the provision of appreciable thermal storage capacity prior to the passage of the steam through the reducing valves to the turbine stop valves at a pressure of 210 lb per square inch. In addition, the final steam temperature on all boilers was increased from 650 deg. Fah. to 725 deg. Fah., for which the new 7500-kW turbo-alternators were designed and the existing 7500-kW units were modified. The new 9000-kVA step-up and 350-kVA unit transformers for the new turbo-alternator units, together with two 2000-kVA station transformers were supplied by Asea Electric, Ltd.

At the same time, all the generator and feeder panel switchgear in the power-house was replaced by equipment which complied with the latest British Standard Specification with regard to rupturing capacity, the equipments being supplied by the British Thomson-Houston Company, Ltd. This was extended to key sub-stations, of which that for Olivos was supplied by the same manufacturer and for Coghlan sub-station by Metropolitan-Vickers Electrical Export Company, Ltd.

The great bulk of the renewals equipment and machinery was manufactured and shipped during the war.

Re-Organisation of Muir Machine Tools, Ltd.

Despite difficulty in the supply of materials and labour and the demand that building operations must not interfere with production, the work of reconstruction of the Britannia Works of Muir Machine Tools, Ltd., in Sherborne Street, Manchester, has just been completed. This firm was founded in 1842 by William Muir, one-time colleague of James Nasmyth, foreman-constructor of Maudslay's Marine Engines and partner of Joseph Whitworth. Following the successful conclusion of a contract for the invention and installation of labour-saving devices at the Woolwich Arsenal, the firm quickly earned a reputation in the design and manufacture of machine tools. Fusion with the David Brown and Sons (Huddersfield), Ltd., organisation brought Muirs the advantages of the experience of other member works and a certain facility in the interchange of personnel to the benefit of both sides.

The continued growth of David Brown and Sons' products had brought about serious congestion at Park Works, and even before the war ended premises for expansion had become an urgent necessity. The Huddersfield site, however, was incapable of further development and the acquisition of Muirs' gave the directors opportunity to merge into the management a section of the Park Works machine tool division. But the Muir works presented a problem in reconstruction. Situated in a district which suffered severely from enemy bombing, some parts of the buildings had not received even emergency patching and all of the roofs needed renewal. The position was complicated still further by the call for complete modernisation of layout and, in part, of reconstruction to accommodate the new plant.

The development plan was divided into twenty separate operations. Work first began in December, 1944, on the Old Mill, a four-storied building abutting the River Irwell which had been in use as a pattern store and was required as a pattern shop. The roof was repaired, the ground floor rendered in concrete, new windows were fitted, a new 2-ton electric hoist erected, and new electrical systems laid. The old pattern shop then became the drawing-office.

All of the Muir planing machines were next moved to new positions on remade concrete floors. The removal of a balcony and staircase, the provision of a pair of sliding doors opening on to Irwell Street and the extension of the crane track, gave a new light fitting shop.

The works first-aid dressing station was moved and at the same time a new electrical sub-station and distribution system were completed.

Demolition of a 20ft wall, the erection of a 14ft wall across the existing heavy turning department, removal of a weighbridge and the extension of the overhead crane track gave gave a new stores as well as an additional entrance to the main street. The workmen's canteen was removed and modernised, and the old site was taken over by the planing department. Demolition of the old first-aid department and works office provided more room for grinding, boring, slotting, milling and final inspection, sections all of which have been re-sited.

Other works completed are: new swarf disposal section and tool maintenance department new "line flow" light assembly and reconditioning department; roof over a new light despatch area; new works administration offices on site of old heavy turning shop; reorganisation of existing first floor offices; new heat treatment department; new boiler house, &c., in basement; new maintenance department; and new aircompressor and service to all departments, except to the pattern shop.

In the new layout three parallel bays house the turning section, heavy machining and grinding section and the planing section. The stores flank the turning bay, and the material flows through the machine shops either to the light fitting bay or to the heavy fitting shop. The heat treatment shop adjoins the stores and turning bay and at the end of the heavy fitting shop is an enclosed department where indexing wheels for large hobbing machines are cut, checked and, if necessary, corrected. The temperature of this room is thermostatically controlled, as is that of an enclosure adjacent to the light fitting shops, where the precision lead-screw master lathe is installed.

The reorganised drawing-office was faced with the heavy task of making all current drawings conform to the David Brown standard. Draughtsmen also had to be familiarised with changed methods of dimensioning and limiting, a system whereby a drawing can be made as complete as possible enabling the planner, the rate fixer and machine operator to complete their tasks without any reference to assembly drawings or drawing-office.

The photographs which we reproduce show the light machine shop as it was before re-siting and reorganisation and in its new form.

Light Machine Shop Before and After Re-Organisation

The James Alfred Ewing Medal

On the joint recommendation of the Presidents of the Royal Society and the Institution of Civil Engineers, the Council of the Institution of Civil Engineers has awarded the James Alfred Ewing Medal for 1946 to Sir Clifford Paterson, O.B.E., D.S.O., F.R.S., for specially meritorious contributions to the science of engineering in the field of research. The medal is awarded annually and was founded in 1936 in memory of Sir Alfred Ewing. Sir Clifford Paterson is in charge of the research laboratory of the General Electric Company, Ltd., at Wembley, Middlesex. His contributions to the science of engineering in the field of research have extended over forty-five years. His work has been particularly outstanding in the development of new sources of illumination, in the study of their use and in their precision measurement. This work was carried out at the National Physical Laboratory until 1919, and later continued after he had joined the General Electric Company. More recently he has co-ordinated the work of numerous teams in connection with outstanding developments in the use of high radio frequencies, thus making possible many of the vital new weapons of defence and offence. The production of special devices and particularly of new valves in quantity has at many stages of the war kept our Services ahead of those of the enemy. Sir Clifford was elected a Fellow of the Royal Society in 1932. He was awarded the Faraday Medal in 1945 and knighted in the Birthday Honours of this year.

Corrosion of Buried Pipes*

Very large quantities of cast iron and steel pipes carrying water, oil, &c., are buried in the soil. An American estimate of the annual loss from the corrosion of buried pipes is £30,000,000. If the conditions are suitable for the action of sulphate-reducing bacteria, drastic corrosion can occur frequently in the dangerous form of localised action or pitting. It is very desirable to prevent or inhibit this, and for this to be possible it is necessary to know the basic facts about the bacterium responsible, particularly its nutritional requirements and to investigate the mechanism by means of which it stimulates corrosion.

The sulphate-reducing bacteria have been known for some fifty years. Their early investigation occurred mainly in Holland, where they were first isolated from canal mud. Recently we have had them under examination at the chemical research laboratory of D.S.I.R. at Teddington. An important sulphate reducer is *vibrio desulphuricans*. This can certainly cause anærobic corrosion, although it may not be the only microbiological agent which can do so.

Mr. Butlin, at the chemical research laboratory has recently made a number of advances in the technical problems involved in the laboratory culture of *v. desulphuricans* in the absence of "soil" and this has helped forward nutritional studies. It is now found that organic carbon is not essential for growth; the organism will develop with carbonate as the sole carbon source. Moreover, although the vibrio develops best in the absence of oxygen, it can live in its presence. In the language of microbiology, the vibrio is a facultative autotroph and is not a strict anærobe. It is also found that iron is an essential growth factor.

An iron pipe buried in the subsoil under anærobic conditions—for example, in heavy clay—will corrode if there are present sulphate and this particular vibrio, and this has been paralleled in controlled laboratory experiments. The way in which the organism brings about the corrosion seems to be this. According to the general theory, the iron will first undergo corrosion by the ordinary galvanic process:

$$Fe + 2\,H_2O = Fe^{++} + 2\,OH^- + 2\,H.$$

The ferrous iron will dissolve at the anode and the hydrogen will be discharged at the cathode and will tend to prevent further action. The bacterial action then comes into play. It involves the reduction of the surrounding sulphate to sulphide, the oxygen being used up in a chain of bacterial reaction terminating with the removal of the depolarising hydrogen

$$H_2SO_4 + 8\,H \longrightarrow H_2S + 4\,H_2O.$$

The corrosion reaction can now go forward again. The hydrogen sulphide will, of course, react with the dissolved ferrous iron, and will precipitate ferrous sulphide, but this is a symptom and not a cause of the disease. In fact, microbiological corrosion of this kind can easily be detected by the black stain of sulphide which appears in the subsoil.

All the parts of this hypothesis have not yet been tested. For example, we want to establish the actual flow of current and to isolate the anodic and cathodic reactions.

Concurrently with these fundamental investigations, field trials have been carried out, and we are also giving advice on the basis of the knowledge so far accumulated to those (such as the Metropolitan Water Board) to whom corrosion of this kind presents an urgent problem.

* Prof. Linstead. Queen Mary College.

Manufacturers and Cleaner Coal

The National Union of Manufacturers has made representations to the National Coal Board with regard to the poor quality of coal supplied to industrial concerns and has asked for more efficient cleaning of coal at the pithead. The National Union has also asked the Board what the future prices of coal are to be, in order that production plans can be made with greater accuracy. In his reply, Lord Hyndley says that the Board fully realises the need for a progressive improvement in the quality of coals marketed to-day, and that it has already taken preliminary steps to secure that end. This matter, he points out, must inevitably take a considerable time, as it involves the reconditioning of existing coal preparation plants and the erection of new ones. Much, however, Lord Hyndley says, can be done in the meantime towards securing some improvement in quality, and the Board is energetically working to that end. The price problem, he goes on to say, is equally a problem that cannot be resolved in a short time. The Board is already engaged on the preparation of a new price structure for industry, with which will be combined a more logical system of grading and sizing, referred to in the report of the Coal Grading Committee of the British Colliery Owners' Research Association. Finally, Lord Hyndley said that in the matter of the price structure before final decisions were reached, the Board would take an opportunity of inviting organised consumers of coal, as well as organised distributors to talk over this important matter.

The Industrial Charter

A statement of the Conservative attitude towards industry, drawn up by the party's Industrial Policy Committee, has now been published (price 1s.) by the Conservative and Unionist Central Office, under the title of "The Industrial Charter." The statement is divided into three main parts, the first outlining the steps which it is considered should be taken to deal with the present crisis, the second defining the place of Government in a free society, and the third setting out a charter of rights and duties designed to give opportunity and status to the worker in industry.

Dealing with the present crisis, the Charter asserts that a high rate of productivity must be restored, pointing out that an increase of only 5 per cent in the national output would be equivalent to another 900,000 men and women joining the country's labour force of about 18,000,000 people. It is suggested that, given incentives and opportunities, workpeople would make this extra effort. On the question o power for industry, the Charter says that the coal target ought not to be less than 220,000,000 tons, and that every alternative means of supplying power and light, including hydro-electric development and the gas turbine, must be encouraged. "Oil can be imported from the sterling area and Iran," the statement continues, "and we will take every possible step to hasten the day when atomic energy is available to reinforce existing sources of industrial power." Transport, food production and capital equipment, including house-building, are also matters which, the Charter urges, should receive priority.

Turning to the place of Government in a free society, the Charter declares that if we are to make the best use of our national assets and to attain the high standards which we have set ourselves, there must be a partnership between the Government, industry and the individual. It is suggested that one Minister should be charged with the duty of surveying our national resources, presiding over the strongest possible committee of Government representatives, employers and trade union leaders, whose business it would be to advise on all questions concerning those resources and how they could best be used. Other matters dealt with in this section of the Charter are wage-fixing machinery, controls, employment policy, taxation, overseas trade policy, the trade unions, monopoly, and nationalisation. On the last point, the Charter defines the grounds of opposition to nationalised industries, saying, amongst other matters, "we are firmly opposed to the nationalisation of iron and steel. Here the Government would be entering competitive and export industry. Furthermore, the ramifications and complexity of the iron and steel industry are so great that the Government would gain an indirect control over many other industries."

"The Workers' Charter," contained in the third section of the report, sets out proposals for security of employment, incentive and status. Some of these proposals are that the employee should have reasonable security in his job and a feeling of assurance that if he leaves it he will get another; that there should be legislation to the effect that every worker, soon after starting a new job, should be given a statement of the terms on which he is engaged and the grounds upon which and the way in which he may be dismissed; and that there should be a comprehensive system of education and training throughout industry, starting with vocational guidance in the schools. A final suggestion in the Charter is that wartime joint production Committees have an important part to play in peace, and the wish is expressed to see them extended for the exchange of information and ideas. "Through them," it is urged, "the individual in the factory can participate in discussion, understand the economic strategy of the country and relate it to his own job."

Atomic Energy Training School.—A training school for boys and girls of 15 years and over is to be opened in August by the Ministry of Supply at the Government Atomic Energy Factory at Springfields, near Preston, Lancs. The training school will give boys and girls, who have studied chemistry at school, a three months' course in the chemical methods to be used at the factory. On the successful completion of the course, students will be given appointments on the factory staff. The Ministry states that Springfields will be used for the manufacture of uranium metal, the processes to be carried out there consisting of the refining of pitchblende concentrates, reduction to metal and the machining and finishing of uranium metal rods which will be sent elsewhere for insertion in a chain-reacting pile. Boys and girls who are taking chemistry as one of their subjects in their School-Leaving examinations will be invited to take part in the work at Springfields. It is pointed out that the programme for the production of atomic energy involves a great deal of chemical analytical work, especially in connection with the chemical examination of raw materials and finished products to be use in the energy-producing units. Although the analytical methods are numerous, complicated and often novel, a great deal of valuable assistance can be given by young persons if they are properly trained and work under expert supervision. Both in the factory operations and in chemical analytical work, the most stringent medical precautions will be taken to avoid any hazard to the health of the workers.

THE ENGINEER

MAY 16, 1947

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NOTICE TO READERS

All letters intended for insertion in THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.

For Subscription Rates, see page 2 of Advertisements.

STRIKES

TOWARDS the end of last month, the Government started a new publicity campaign, the keynote of which is "We're up against it! We work or want." By means of posters, Press advertising, factory talks, display sets, wall charts, and films, it is hoped to impress upon the people of this country the facts of the existing economic situation, and it is acknowledged that many of them are hard and unpleasant facts. In announcing the start of this campaign, the President of the Board of Trade said again what has been said so often in recent months, that neither Government alone, nor management alone, nor workers alone, can put the situation right; only a combined effort will do it; only the efforts of the whole team can pull the country round; the situation is in truth "a challenge to British grit."

It is disappointing that the beginning of this new campaign of exhortation to combined effort should have been overshadowed by the various unofficial strikes which have occurred in recent weeks. For six weeks, 3800 Glasgow dockers were engaged in a strike, as a protest against the dismissal of 500 men on the grounds of redundancy, and for one week over 9000 men employed in the London docks struck work in sympathy with them. In the City of London, 1000 Corporation employees were engaged in an unofficial strike which led to Tower Bridge being closed for several days, thereby causing considerable traffic congestion; while, early last week, a sudden strike of a few hundred winding men at collieries in the North of England prevented some thousands of coal miners from starting satisfactorily their first official five-day week. In the first three months of this year, there were 459 disputes leading to stoppages of work, reported to the Ministry of Labour, involving in all 165,500 workers, and resulting in an aggregate loss of 682,000 working days. It is difficult to escape the feeling that most if not all these disputes could have been settled without stoppages of work. There is perhaps a measure of satisfaction in recalling that the number of working days lost through disputes since the end of the war is only one-tenth of the number lost in the two years following the 1914–18 war, but, as the Attorney-General pointed out in a recent speech, "it is one-tenth too much, and there should be no unofficial strikes now."

Mere condemnation of unofficial strikes, however, is not enough to prevent them taking place. What is of greater importance is that the disputes which lead to them should be promptly settled before recourse to strike action is sought. The trades unions of this country have many times lately expressed their pride in the joint negotiating machinery that has been built up over the years. Yet complaints about the inordinate length of time taken over negotiations have not been absent when considering the "whys" and "wherefores" of some unofficial strikes. In the same way, the Government has stated that it does not propose to interfere with the existing machinery for negotiation between employers and employed and in the case of unofficial strikes has insisted that this machinery must be used for settling the disputes. At a time when the nation is faced with the bitter truth "Work or want," unofficial strikes are particularly deplorable. They are, surely, a sign that we have not yet reached the stage when it can be said that the "efforts of the whole team" are pulling the country round, or indeed, that the "challenge to British grit" is being taken up wholeheartedly. At the same time, they may be a sign that the will to work hard is less apparent than it was, or that the voluntary machinery for settling disputes with which the unions and the Government appear to be so well satisfied is creaking badly and calls for rapid overhaul.

EXHIBITION PLANS

A NUMBER of exhibitions of engineering interest have recently been held in this country, and the latest of them, the British Industries Fair, closes to-day. Further exhibitions have been arranged for the second half of the year, including, in particular, the Shipping and Machinery Exhibition, to be held at Olympia in the first weeks of September. Such exhibitions must, naturally, raise the question whether it is wise in days of scarcity to publicise by that means products the output of which is at present restricted and unequal to the demand. But by their strong support of these shows, the engineering firms of this country are, we think, clearly expressing their opinion that however embarrassing it may be to have to quote long-distant delivery dates, it is still worth while to show prospective buyers what they have to offer.

The majority of firms with stands at exhibitions frankly admit that their order books are already overflowing, and that delivery dates in less than twelve months can rarely be given. At the same time, much development work is still in progress in the light of improvements in materials and manufacturing methods which have taken place during the war years. Many of the resulting improved products are, however, not yet in production. Many firms have, indeed, made strenuous efforts and prepared prototypes of new machines for exhibition, but with the present state of industry, owing to the restrictions imposed upon fuel and power, and material shortages, it is not easy for even the more optimistic manufacturers to quote reasonable delivery dates even for standard products with assurance. It must, of course, be recognised that a wide range of basic plant is of a kind which will always be in demand and is urgently required in many foreign markets, more concerned in getting industry going than in obtaining the more up-to-date machines. But a further difficulty arises in the selection of suitable staff to demonstrate and deal with technical enquiries on the exhibition stands. Such men are not particularly plentiful in any establishment now, and their knowledge is such that they can ill be spared from the works where their services are continuo sly in demand. The difficulties, which face engineering establishments in this country, are, of course, a natural result of the complete change-over to war production, which took place throughout industry in its all-out war effort, and the serious drain upon manpower for our military commitments. But the way in which the engineering industry has got back into normal peacetime production in so short a period, despite the many difficulties it faced, has constituted, we think, a remarkable feat. To undertake the organisation of an exhibition programme in the midst of that change-over has called for no little enterprise. Nevertheless, from the preliminary information which is already coming to hand about future shows, and from what has already been seen at the Fair which closes to day, it is evident that engineers are doing their utmost to produce displays of plant up to the traditional high standards set by this country prior to the late war.

It is certainly important to industry that foreign buyers who have had no chance to inspect a representative selection of the goods produced in this country for at least seven years should be given an early opportunity to see their merits and appreciate their range. Maybe visitors from abroad will not be able, in many instances, to hope for the speedy delivery they desire, but there is no shadow of doubt that they must be again impressed with the quality, range and design of British plant. Moreover, it is surely important that they should be able to see those products now, even if delivery dates are distant. For having once seen them they may well feel it desirable to wait to obtain the articles

they really want rather than go elsewhere for less suitable but more easily available plant. Much has been said and written about the fact that the sellers market which prevails at present throughout the world will not last very much longer. What could be wiser then than to convince that market now that British made plant and machines are as good and indeed better than ever and as such are well worth waiting for?

Literature

Talks About Steelmaking. By HARRY BREARLEY. The American Society for Metals, Cleveland, Ohio. 1946. 3.50 dollars.

MR. HARRY BREARLEY, whose collection of reminiscences "Knotted String" aroused much interest some years ago, has written, under the title of "Talks About Steelmaking," another characteristic book, which, as he says, is "part suggestion, part history, part criticism and essentially a biased point of view, from which I have found steelmaking an attractive occupation."

It is an entertaining and readable book in which there is a distinct echo of the opinions, often controversial, but always based on personal experience, that Mr. Brearley has expressed before in his more scientific books, in discussions and in articles contributed to the technical Press. The historical part consists mainly of brief sketches of Huntsman, Bessemer, Siemens and S. G. Thomas. A fresh interpretation is given to some of the almost legendary stories about Huntsman. Other historical notes are introduced incidentally. For instance, readers are reminded that the tensile test, devised about 1720 by Réaumur, was first used to ensure the completion of the refining operation in the manufacture of puddled iron. The tensile strength of wrought iron was thus a guarantee of its softness. It later became an acceptance test for the engineer, minimum requirements were laid down and the test was incorporated into specifications, "thereby acquiring an authority and tradition which can maintain it for a long time in spite of inherent ignorance and folly." Mr. Brearley evidently has not much use for the tensile test. "The tensile machine," he says, "has its uses. It is an attractive story-teller for those who are listening to the story for the first time. It is useful for making proof load tests." The proof load, however, does not apparently stand much higher in his estimation, since he regards hardness as measured by an indentation test, and toughness as measured by the notched-bar impact test, as the essential mechanical characteristics of a steel. "The engineer desires hardness combined with toughness; a sufficient amount of the one and as much as he can get of the other." "The most useful control tests for steelmaker and user are the Brinell test to measure hardness and the Izod test to measure toughness."

Mr. Brearley has always been a strong supporter of the notched-bar impact test, and a substantial part of several chapters of the book deal with the history of the Izod test, the way in which it should be applied and the indications of comparative longitudinal and transverse Izod values. "That Izod figures cannot be made the basis of calculation in the engineer's designs may be true, but they indicate an important element of reliability when material is heavily stressed under unfavourable conditions. They represent the guts of steel, and the nearest thing in testing systems to what was once called 'body.'"

The last chapter of the book deals with the important subject of the economic utilisation of scrap. "Scrapalurgy" is the term invented to cover the scientific principles which should underlie the practice of the scrap maker and the scrap user. The author puts in a plea for waste-recovery plants operated in the first instance by a trade control federation, and later by scrap users themselves, for the remelting of alloy steel turnings and so avoiding the wasteful use of valuable alloying elements. The economic use of scrap necessarily involves difficulties in meeting narrow limits of chemical composition, and the chapter ends with another appeal to the specification maker who must be made to realise that most scrap is now contaminated with alloy elements, some of which, like nickel, can be put into steel but cannot be taken out again.

Those acquainted with Mr. Brearley and his writings will not be surprised at the evidence in this book of his warm sympathy with all ranks of the steel-making fraternity, shown in his admiration for those who, through a hard apprenticeship in "grime and sweat," have attained positions of responsibility, and in his anxiety for the welfare of all recruits to the steel industry, for their education and proper remuneration, and for the maintenance of the pride of craftsmanship, even by the humblest worker. As the older forms of craftsmanship decay some fresh human interest in the work must be substituted. Improved rates of pay alone will never suffice. "If there is less and less reason in a man's job, it is folly to expect him to grow reasonable; he must grow either frantic or daft."

This is a revealing book, and is to be welcomed as an expression of the personality of one who will always hold a distinctive place in the annals of metallurgy.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

INSTITUTION AMALGAMATION

SIR,—Your leader and article on the above subject in your April 25th issue is symptomatic of what is in the minds of many engineers to-day, which is further evidenced by articles and letters in recent issues of your contemporaries *The Surveyor* and *Contractors' Record*.

Before attempting a brief analysis of the position perhaps you will allow me to quote from Sir William Halcrow's Presidental Address to the Institution of Civil Engineers, 1946.

"Perhaps the greatest obstacle to-day to the presentation of the views of the profession as a whole on matters of general and public interest is the large number of existing institutions, the effect of which, unfortunately, is to increase the number of voices, to the detriment of unity and concerted action, when a wiser and more effective policy would be to reduce them. One may perhaps rightly criticise the policy of our predecessors of forty or fifty years ago. Had they foreseen what, in fact, has happened, they would no doubt have provided for sectional divisions in the Institution specialising in the various branches of professional work. Unfortunately, nothing, or at any rate nothing effective, was done to this end, with the result that many independent institutions and professional societies came into being.

"During the period under review efforts have been made to bring about the amalgamation of some of the smaller institutions, but without success. Taking a broad and long view, the advantages of amalgamation are so great that it is difficult to understand what those who oppose practicable and equitable proposals to this end expect to gain by standing aside. Certainly members do not gain, because, if they belong to two institutions, they pay two subscriptions instead of one. I can only hope that members will do all they can to encourage the effective union of institutions, or at least co-ordination of effort, and I would particularly stress the desirability of this in the case of those institutions closely allied to us."

It is an indisputable fact that without the technical and organising ability of engineers, we would never have won the war, and it is no less true to state that these same attributes, inherent in the training and experience of engineers, are an essential factor in our industrial and economic recovery.

Notwithstanding the essential nature of the work of engineers to the community as a whole, their professional and economic status is much below that of other professions. This is partially due to engineers themselves who were so busy organising the real work of the country that they had never given sufficient time and thought to the job of organising themselves.

The present revolution which is taking place in the economic system of the country—and this is a fact, whether we believe in the change or not—should make the members of the engineering profession pause, and consider their position in the future State, as it will be in, say, five years' time.

The advances made in the field of mechanical and electrical engineering are such that it is hopeless to consider them as linked up with civil engineering as the average man generally understands that term. The report of the wartime investigating committee, which recommended the establishment of R.E.M.E. as a separate entity from the Royal Engineers, recognised this point. The work dealt with by civil engineers in the accepted sense by the "man in the street" is covered in the main by three major institutions, two of which have Royal Charters:—The Institution of Civil Engineers, the Institution of Structural Engineers, the Institution of Municipal Engineers.

As mentioned, we are at present undergoing a tremendous change in our economic life, and it is suggested that if the programme of the present Government is carried through, at least 90 per cent of the engineers in the three institutions listed will be in Government or quasi-Government or local government employment. Another very difficult problem which engineers will have to face, on an increasing scale, is the present policy of departmental heads being of the administrative officer grade. The tendency is for these people to be placed in complete charge of, say, a regional office of a Government Department, which is wholly technical, although these "administrators" have no technical knowledge of the subject which they administer. This is perhaps one of the chief faults of the present organisation of the Civil Service, but so far as engineers are concerned, it means their subordination in status, not only to members of kindred professions, but to clerks in the form of administrative officers.

Only those engineers who are up against this problem appreciate how very difficult it can be.

The question is one which affects younger members and students in particular, and senior members with established positions should remember this point and not try and "kill the idea at birth" before it can be considered by the members of the institutions as a whole.

In considering the question of amalgamation further, it is worth making a comparison between civil engineering and the medical profession. A glance at *The British Medical Journal* (the official organ of the B.M.A.) will convince the reader that it can and does speak for the profession, not only on questions of status—that is quite a small part of its work—but on technical and scientific questions which affect the profession in its work for the community. Government Departments dealing with questions of status and employment find it most difficult to "sort out" who's who in the field of civil engineering; on the other hand, there is no question in anyone's mind but that the B.M.A. represents, by and large, the medical profession as a whole. This lack of cohesion in the civil engineering profession is reflected adversely in salary scales of all Government or quasi-Government employment.

It has been suggested that effective action could only be taken by registration, but that would be a matter for the new Council of the reconstituted institution to decide. It is suggested, however, that if the architectural profession is a guide, then amalgamation is a necessary prerequisite to registration or any other statutory regulation. The architects have largely lost many of the benefits of registration by their continued divisions. Any attempt to set up an Association of Engineers with the object of looking after only the status of the engineer is doomed to failure. Quite apart from the fact that it would cost the individual engineer another fee, the problems which require strong representation cannot be separated easily into technical or status problems; they are intimately interlocked, and we need the same organisation to deal with both.

The benefits which would accrue from the amalgamation suggested are enormous. The saving in administration expenses would be such as to give us some of the hard cash which all three institutions lack to-day for research and scientific advancement. Since the failure of the Engineering Joint Council on reciprocity arrangements at examinations, these have again become a nightmare for students, who have to take the examinations of two or more of the three institutions to secure an appointment.

Attempts have been made in the past, at Council level, to obtain amalgamation, but for reasons unknown to members these have been abortive. Let us hope that the Councils of the three named institutions will now take their members into their confidence and let the decision be arrived at in a truly democratic manner.

CIVIL ENGINEER.

April 30th.

BOOKS RECEIVED

Infra-Red Heating. By A. E. Williams. Manchester; Emmott and Co., Ltd., 31, King Street, West. Price 2s. 6d.

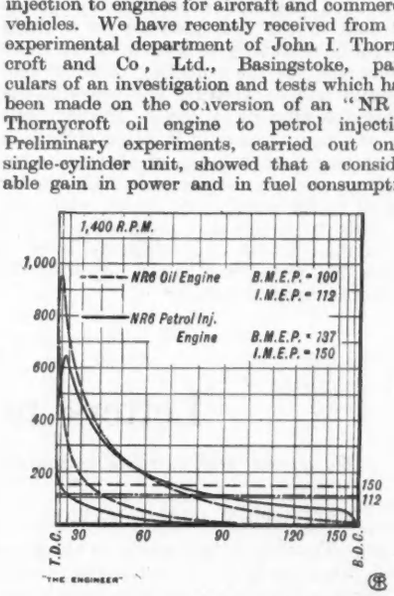
Production Costs and Estimates. By Andrew Miller, F.C.W.A. London: Gee and Co. (Publishers), Ltd., 27–28, Basinghall Street, E.C.2. Price 12s. 6d. net.

Examination of Industrial Measurements. By John W. Dudley. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, Aldwych, W.C.2. Price 10s.

Pratical Cost Accounts. Fourth edition. By Andrew Miller, F.C.W.A. London: Gee and Co. (Publishers), Ltd., 27–28, Basinghall Street, E.C.2. Price 12s. 6d. net.

A Petrol Injection Commercial Vehicle Engine

CONSIDERABLE interest has recently been displayed in the application of petrol injection to engines for aircraft and commercial vehicles. We have recently received from the experimental department of John I. Thornycroft and Co, Ltd., Basingstoke, particulars of an investigation and tests which have been made on the conversion of an "NR 6" Thornycroft oil engine to petrol injection. Preliminary experiments, carried out on a single-cylinder unit, showed that a considerable gain in power and in fuel consumption could be made. The "NR 6" engine chosen is normally fitted in a commercial vehicle of 22 gross tons, and it was found that with petrol injection, 33 per cent extra torque could easily be attained with an output of about 50 per cent more horsepower. This petrol injection installation is claimed to be the first of its type to be put into production in this country.



INDICATOR DIAGRAMS OF "NR 6" ENGINES

Among the principal claims made for petrol injection are that better volumetric efficiency is brought about by the use of large-bore fuel inlet pipes, the absence of any carburettor choke or hot spot; no necessity to take in cold air from outside the bonnet of the engine; better distribution and atomisation of fuel, and improved mixture control all the way through the throttle range. These factors, it was found, led to a higher output and a better consumption, as compared with a similar carburetted engine.

THE "NR 6" OIL ENGINE

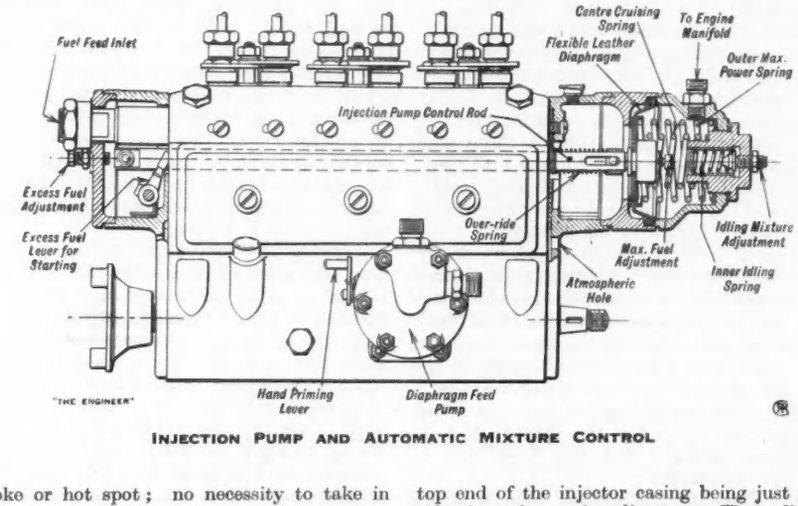
The "NR 6" oil engine was chosen for conversion, because of its capacity to withstand higher bearing loads brought about by the extra power developed, and its greater adaptability for the petrol injection design. The larger scantlings of the engine would, it was felt, provide a long life with exceptional reliability. Moreover, the "NR 6" engine was already in production, which was attractive from the points of view of cost, service and interchangeability. The engine is rated at 100 b.h.p. when running at 1800 r.p.m., the maximum torque being 328 lb-ft, corresponding to a b.m.e.p. of 103 lb per square inch at a speed of 1000 r.p.m. It has a compression ratio of 16 : 1 and at a speed of 1400 r.p.m. its compression pressure is 562 lb per square inch and the maximum pressure 931 lb per square inch, as shown on the accompanying indicator diagram. In common with most other direct-injection oil engines, it is governed to a speed of 1800 r.p.m. and when fitted in an eight-wheeled chassis designed to carry a gross load of 22 tons, its consumption is 8·25 miles to the gallon, giving a figure of just over 180 gross ton-miles per gallon.

THE "NR 6" PETROL INJECTION ENGINE

The "NR 6" petrol injection engine is similar to the "NR 6" oil engine, with differences in cylinder heads, pistons and fuel pumps, and timing drive. A general view of the engine and a part section is given herewith. The engine is a six-cylinder unit with a bore of 4½in or 104·8mm and a stroke of 6in or 152mm, giving a total swept volume of 7880cc. The compression ratio is 6·92 : 1, which gives a compression pressure of 175 lb per square inch, and at 1400 r.p.m. an explosion pressure of 650 lb per square inch. It produces 150 b.h.p. at 1900 r.p.m., and a maximum torque of 445 lb-ft, which is equivalent to 140 lb per square inch b.m.e.p. at 800 r.p.m.

As will be seen from the drawing, the cylinder heads are of special design, incorporating large ports. They still retain a water space between the inlet and the exhaust port in order to provide good cooling for the valve seats. The fuel injector, it may be noted, is let down into the inlet port so that its nozzle is within about ¼in of the head of the inlet valve. The top end of the injector casing being just outside the valve spring diameter. The cylinder heads are cast in such a way that the near-side face, to which the water cooled exhaust manifold is bolted, has open spaces through which the cooling water flows from the cylinder heads into the exhaust manifold and thence to the top of the radiator. These side openings serve a useful purpose in enabling the inside of the cylinder head casting to be thoroughly cleaned and all trace of sand from the cores removed.

The object of water-cooling the exhaust manifold is to reduce the amount of heat im-

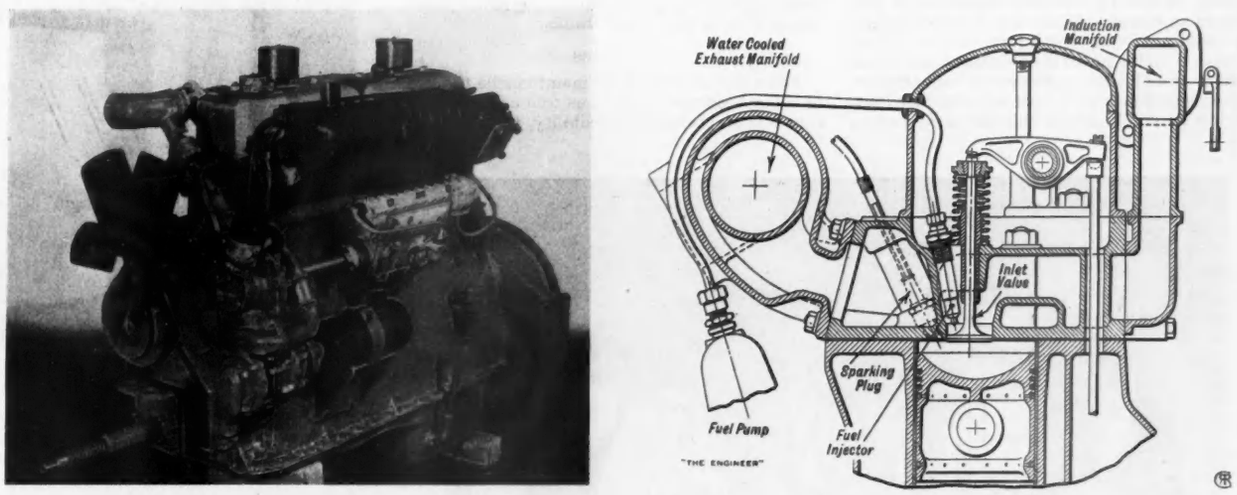


INJECTION PUMP AND AUTOMATIC MIXTURE CONTROL

parted to the fuel pump, which is mounted just below and thereby to avoid the formation of vapour locks; this point was very carefully investigated. The water-cooling of the exhaust manifold serves also to keep a low under-bonnet temperature and prevent vapour locks in the petrol pipes leading to the fuel pump. Both the inlet ports and the manifolds have been designed with the largest areas possible in order to improve volumetric efficiency. The design of these parts is not restricted, as it would be in a carburettor engine, by the necessity of having comparatively small bore induction pipes to maintain the speed of the air and to keep the petrol vapour in suspension. Special attention was given to the breathing system of the engine and a continuous supply of cool, clean air is taken in through two Vokes air filters, placed on the top of the valve covers. The air then passes through the valve gear chamber, down through the tappet gear, slow cam lift, plunger back leakage is kept to a minimum. Reduced capacity unloading type delivery valves, specially designed to reduce fuel line pressures to zero with a minimum of delay are fitted.

As the pump is directly driven by the engine, it responds immediately to changes in engine speed, so that the problem of mixture resolves itself into metering the cyclic output of the pump in accordance with the air-charge weight per cycle received by the engine. Ignoring temperature variations and altitude conditions, a simple and reliable control capable of easy adjustment has been obtained. The mixture control operates by means of induction manifold depression, and it consists of a flexible leather diaphragm, which is connected to the end of the pump control rod. The left hand side of the diaphragm is exposed to atmospheric pressure, whilst the right hand side is placed in communication with the induction manifold to be adjusted by movement of a screw and a lock nut, and of allowing the mixture control to be overridden in order to obtain a rich mixture suitable for starting from cold. The override is housed in a small casing at the opposite end of the pump. At this position a small pin and roller is carried on an extension to the control rod and a lever connected externally to the driver's cab makes contact with the roller, so that the pump control rod can be pulled away from the diaphragm unit by compression of the override spring. A hand throttle control is fitted in the induction manifold. This control consists merely of an air bleed, which is adjusted by a lever placed in a position convenient for the driver. There is no mechanical linkage whatever between the accelerator pedal and the hand throttle.

Petrol is supplied to the injection pump by a C.A.V. diaphragm feed pump. This pump is bolted directly to the front of the injection



GENERAL ARRANGEMENT AND PART SECTION OF "NR6" PETROL INJECTION ENGINE

and through the sump to a large diameter breather pipe, into which is inserted an Amal flame trap. It passes thence into the induction pipe on the atmospheric side of the throttle. The distributor is of C.A.V. type, incorporating an automatic advance with speed, and also a part throttle advance with vacuum control.

The consumption figures for the engine are of interest. At 800 r.p.m. for a b.m.e.p. of 140 lb per square inch, a full-load consumption of 0·508 lb per b.h.p. per hour is attained, whilst at 1800 r.p.m. it does not exceed 0·55 lb per b.h.p. per hour for a b.m.e.p. of 131 lb per square inch. All the tests were made with ordinary Pool petrol of 70 octane number, with a specific gravity of 0·745 and a lower calorific value of 18,500 B.Th.U. per lb. These figures produce on the road a value of gross ton-miles per gallon in excess of 130, which very closely approaches that obtained with an oil engine of the ante-chamber type, namely, 140 to 150 gross ton-miles per gallon.

The air fuel ratios vary between 13·25 : 1, at full throttle and 14·75 : 1, under economical cruising conditions.

Petrol Injection Equipment

Particular interest attaches to the petrol injection equipment used on the engine, which was developed by the Thornycroft experimental department, in co-operation with the C.A.V. Research Laboratories. As will be seen from the accompanying drawings, it consists of an injection pump, feed pump, filter and injectors, with an automatic mixture control and an excess fuel device for starting. The pump used is basically the standard ".B" size unit generally employed on commercial vehicle engines. It has a plunger diameter of 7½mm and a stroke of 10mm, and embodies a new camshaft with eccentric cams, designed to give a long injection period. Owing to the low opening pressure of the injectors and the pressure through a flexible pipe. Thus the net pneumatic force on the diaphragm unit is the induction depression multiplied by the area of the diaphragm. This force is opposed by a nest of three springs housed inside the diaphragm chamber, which are so adjusted as to make contact with the diaphragm unit successively throughout the travel of the pump control rod. Movement of the diaphragm to the left, the direction for increase in fuel supply, is limited by the circumferential ledge formed in the mounting plate casting, which prevents further movement of the diaphragm support plate. This is the position for full load when the manifold depression is at its minimum and in this position only the outer or full-load spring is in contact with the diaphragm unit. In this position the spring is at its free length and shim adjustment is provided so that the slightest increase in the manifold depression moves the diaphragm to the right, away from the stop, pulling the control rod with it, and so reduces the quantity of fuel delivered.

Increasing manifold depression causes further movement to the right until contact is made with the centre or cruising spring. The pneumatic force now acts against the combined pressure of the two springs, so that the rate at which fuel delivery is reduced for a given manifold depression is decreased. Finally, as the depression approaches that obtained under idling conditions, at a pressure of about 18in of mercury, contact is made with a third spring, thereby increasing further the spring pressure. This third or idling spring, as it is called, is capable of external adjustment by means of a screw and a lock nut.

The excess fuel device for starting purposes consists of a slotted link, loaded by means of an override spring attached to the diaphragm unit and the control rod. It serves the dual purpose of allowing the maximum fuel setting pump housing and it is operated by an eccentric mounted on the camshaft. The pump is self-regulating to a pressure of about 5 lb per square inch and it has a hand-priming lever. The injector is of the spring-loaded poppet valve pattern and is designed to give a conical spray. The advantage of the poppet type of nozzle is the absence of any leak-off, which would necessitate the fitting of additional return piping, similarly to that used with normal diesel oil injection nozzles with differential needle valves. Reduction in size is another advantage of the poppet type of nozzle, and as will be seen from the accompanying drawing the nozzle is very small, the spindle diameter being only 2mm. The holder can also be made almost any size to suit the particular design. The opening pressure of the poppet nozzle is very low, being only about 367 lb per square inch, a pressure which has been found adequate to ensure good atomisation and mixing.

Running costs for eight-wheeled commercial vehicles with oil and petrol injection engines have been prepared by John I. Thornycroft and Co., Ltd., with the vehicles laden to 22 tons gross, and are based on the performance round a twenty-eight miles course. These figures are tabulated below.

Item	Petrol injection engine	Oil engine
Miles per gallon	6·2	8·25
Gross ton-miles per gallon	136	181
Average speed, miles per hour	25·9	16
Gross ton-miles per gallon per hour	126	103·5
Fuel cost per mile in pence	3·71	2·24
Drivers wages per hour	2s. 6d.	2s. 6d.
Mates wages per hour	2s. 0d.	2s. 0d.
Personnel costs per mile in pence	2·08	3·38
Total cost per mile in pence	5·79	5·62

ALBERTA'S COAL OUTPUT.—Coal production from the Alberta mines in 1946 totalled over 8,750,000 tons, or nearly 1,000,000 tons more than in 1945.

Lightweight Traction Motors

FROM the inception of d.c. electric traction on the L.S.W.R. in 1915 to the present time it has been the policy of the Southern Railway to use totally enclosed traction motors on its electric multiple unit stock. Though the totally enclosed motor is larger and heavier than the equivalent ventilated motor, the policy was sound from an operating view point. Breakdowns have been rare and maintenance costs have been light.

For the present era, however, higher accelerations and higher average and maximum train speeds, with higher passenger loads are being envisaged. The continued increase in the numbers of electric vehicles, coupled with progressive improvements in traction motor design, have indicated that the adoption of a lighter ventilated motor for both suburban and express services would have considerable advantages. Higher continuous motor output with less deadweight would facilitate higher acceleration, reduce energy consumption and lessen mechanical stresses on bogie and track.

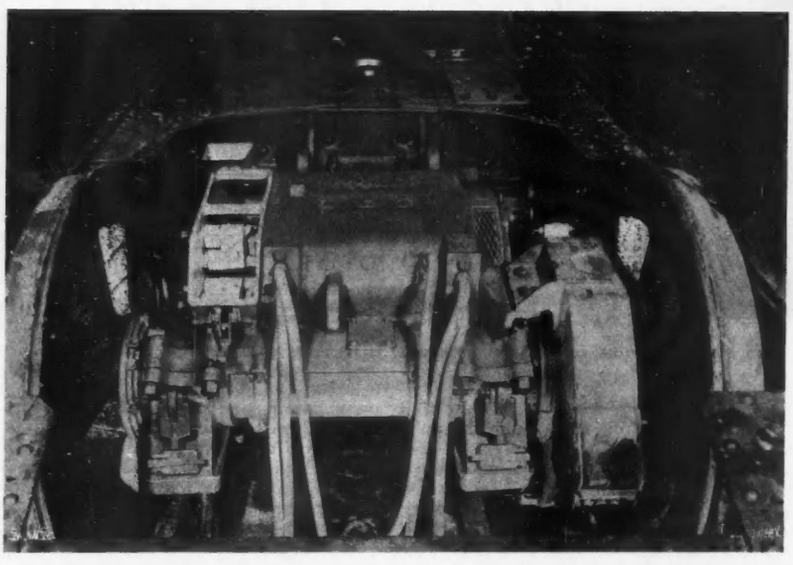


FIG. 1—MOTOR IN POSITION ON BOGIE

In anticipation of these needs, the development of a suitable motor was undertaken as opportunity offered during the war. After satisfactory preliminary tests, the first four of the new motors have recently been completed, and have entered suburban service on four-coach unit No. 4130. These motors have tapped fields, and are so designed that on full field they reproduce the characteristics of the standard type 339 suburban motor. With weakened field the standard express, type 163, motor performance can be obtained. The new motors can therefore be used on either class of service, and their easy interchangeability will greatly simplify maintenance procedure, and result in reduced costs. The additional field cable thimble (required for working with weakened field) is housed for convenience in a dummy terminal in the motor connection box on the coach underframe. It is not the intention at the moment to add field tap contactors to the motor coach control gear.

Motor	339.	163.	Lightweight.
Weight, total tons *	3·6	3·38	1·92
H.P., max. accelerating	300	210	300
H.P., continuous	—	—	180
Type	Totally enclosed	Totally enclosed	Ventilated
Max. safe armature speed, r.p.m.	1600	1680	2550
Gear ratio	21 : 59	23 : 57	17 : 65
Bearings	Sleeve	Sleeve	Roller

* Includes gears and gearcase.

Comparative particulars of the three motors are given in an accompanying table.

An accompanying engraving shows the appearance of the lightweight motor as mounted on the bogie, the fan being at the pinion end of the shaft. The commutator cover has been removed, and behind it, to the left of the illustration, can be seen the air inlet flange. Six connecting leads are shown. The third lead from right is the power circuit negative return connection to the motor frame.

BEARINGS

From the view point of maintenance the use of roller bearings for axles as well as the armature was an attractive possibility, the merits of which were carefully considered. It was decided, however, that, although roller bearings had proved successful on traction systems with an insulated return, their use for axle suspension on a running rail return system might cause trouble. Under heavy current conditions, such as overload or fault on the power circuit, it is difficult to shunt roller bearings effectively with an axle earth-brush arrangement, and in view of the damage likely to result from pitting of races and rollers it was felt to be advisable to retain the sleeve bearings, but in an improved form. By using welded construction in place of the usual heavy cast steel bearing caps and oil boxes, these parts have been reduced in weight by 50 per cent, while the oil capacity has been doubled. This increase in oil capacity, together with the use of grease-lubricated armature bearings, allows a greater mileage to be run between oiling dates, resulting in improved economy and greater availability of stock.

As this was a trial installation, it was felt to be desirable to arrange the additional provision required for self-ventilated motors in such a way as to involve the least possible alteration to the coach bodywork and underframe. In the unlikely event of the new motors not proving satisfactory, they could be replaced by standard 339 motors with little trouble

VENTILATION

Ventilating air for the motors is drawn through ducting in the guard's van from a settling chamber supplied from louvred openings in the coach roof. Each motor requires a volume of cooling air, which rises to 600 cubic feet per minute at 60 m.p.h. Amp'e duct area was therefore necessary. At the same time, the ducts themselves were kept as flat as possible for the sake of appearance. As no running experience under Southern Railway conditions was available, it was thought best to err on the side of safety, and the settling chamber in the van roof was included in the lay-out, so that as much as possible of the dust and moisture in the incoming air could be deposited clear of the motors.

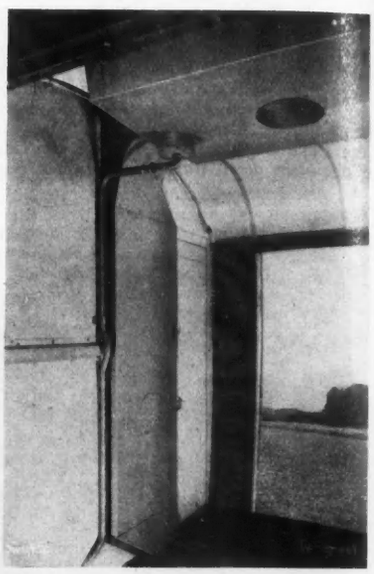


FIG. 2—MOTOR VENTILATION DUCTING

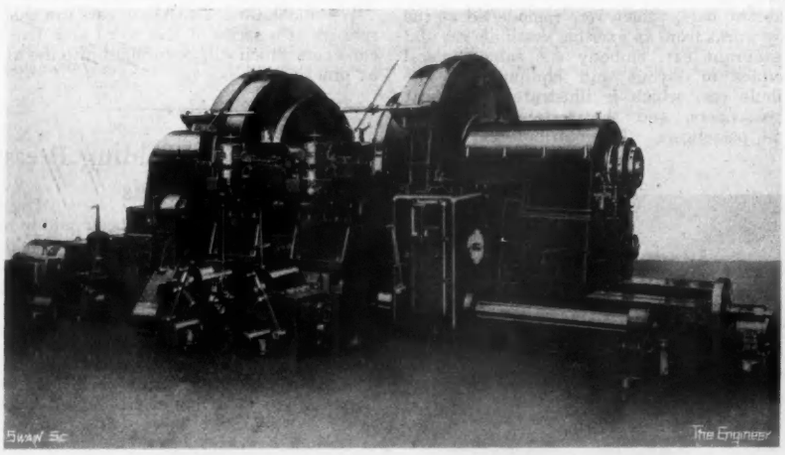
A ventilating system that will run between major motor overhauls (a period of twelve to sixteen months) without attention for cleaning is the ultimate aim. Only time and experience will show whether this aim is likely to be attained, and what modifications in the duct system are necessary to achieve it.

FIG. 3—COMBINED FLOOR PLATE AND DUCT SECTION

A general impression of the ventilation arrangements is given in two of the accompanying engravings. One illustration shows the ducting to No. 1 motor, arranged against the van partition, the roof settling chamber and the drain. The two circular plates cover the cleaning and inspection openings. Restriction of space available for ducting under the floor, coupled with the need for providing the usual access to commutators and gears gave rise to a design problem that was neatly and effectively solved by combining portions of the ducting with floor inspection covers, as shown in our final illustration, which is reproduced from a photograph taken during erection and before the motor leads had been connected.

Heavy Duty Wheel Lathes

A NUMBER of "Loudon" heavy duty wheel lathes has recently been completed for the French Railways by the Scottish Machine Tool Corporation, Ltd., Glasgow. These single-purpose machines have been designed and built to exacting specifications and their rigidity, coupled with their power and speed, enables tungsten carbide tools to be used to full advantage. They will be used for re-forming and profiling mounted wheel sets from 4ft 6in diameter to 7ft 6in diameter, on a gauge of 4ft 8½in. Each machine has a range of spindle speeds from 0·5 r.p.m. to 8·84 r.p.m., and the twelve feed changes vary from $^1/_{50}$in to $\frac{3}{8}$in per revolution of the spindle.



HEAVY DUTY WHEEL LATHE

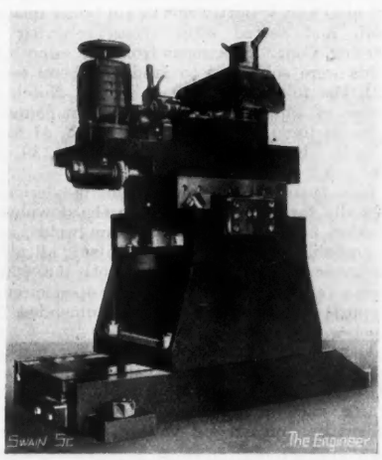
In the photograph we reproduce above is shown one of the 7ft 6in diameter wheel lathes having electric controls throughout, except for the pneumatic locking mechanism fitted to the loose headstock and tools. This locking mechanism is operated by compressed air at a pressure of 100 lb per square inch. We are informed that, if required, electric locking of these parts can be arranged in order to make the machine fully electric in operation.

The loose headstock has a quick power traverse motion, which is driven through the motor to be seen mounted on a sole plate attached to the end of the bed. A safety slipping clutch is provided on the forward traverse mechanism of the loose headstock, and a safety limit switch guards against over travel during the backwards traversing movement. This headstock, as stated above, is locked in position by pneumatic power, but a hand-operated friction cone arrangement can be used in the event of a failure in the air line.

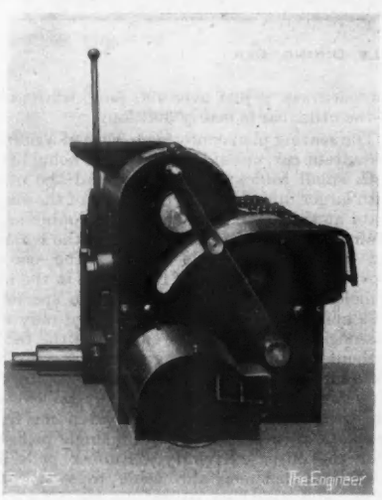
A calipering device on the lathe is supplied to ensure that the wheels are accurately turned to the same diameters.

Each faceplate is mounted on a large spindle, revolving in phosphor bronze bushes. Holes provided at the bottom of four circular rows of tee slots in each faceplate are used for anchoring the driver stopper. The faceplate drivers are of the spoke type and can be easily manipulated and set to accommodate all wheel sets of this pattern.

The centres in the headstocks are arranged on a power-controlled retractable slide and a slipping device is designed to come into effect immediately the retractable centre has reached its working position. A push button control for the fast headstock centre is mounted on the main driving gear-box, whilst that for the loose headstock centre is set on the front of its gear-box.



RIGHT-HAND SLIDE



RIGHT-HAND FEED BOX

Main drive is transmitted from a two-speed motor, through a six-speed gear-box, the motor speeds being 727 r.p.m. and 1460 r.p.m. The change from roughing to finishing speeds is effected through a push button control.

The main driving shaft of high grade steel runs in gun-metal bearings and the final drive to the faceplates is through large cast steel gear rings driven by high tensile forged pinions. The driving gear teeth are accurately machined with a pressure angle of 20 deg. The pinions are supported in out-end bearings.

A totally enclosed change-speed gear-box is mounted on the front of the lathe bed, and in it the high tensile steel gearing is flood lubricated. On the first motion shaft of the gear-box, where high peripheral velocities are encountered, the gears are hardened and their teeth profiles are ground to reduce noise and vibration to a minimum.

One of the two sets of compound rests is illustrated herewith. These rests are of particularly heavy construction, each being independent and consisting of a saddle on the lathe bed, pillar slide, swivel slide, intermediate slide, and a steel in-cutting slide. The swivel slide permits the turning of the wheel tread taper and the maintenance of the traverse adjustment at right angles to the axis of the machine. The pillar slide is adjustable by hand to suit varying wheel diameters. Sheet steel trays are fitted to all slide rests for conveying the turnings to the bed recess, and the bearings are fully protected. Each slide rest has its own feed gear-box, which is bolted to the front of the bed. These gear-boxes provide continuous geared feeds, from $^1/_{50}$in to $\frac{3}{8}$in per revolution of the spindle. The feed selection lever on each box is set within easy reach of the operator. This continuous geared feed mechanism, also illustrated is designed to suit high-speed cutting with special alloy tools. Tool clamping is effected by pneumatic means and locking therefore calls for no effort on the part of an operator.

Means of quick power traverse are provided for the inter and in-cutting slides of each rest. This power traverse is driven by separate flange-mounted motors, controlled by joy-stick type switch levers on the individual feed gear-boxes. An electric interlock is fitted between the feed and traversing mechanisms.

With its electrical equipment, each of the new wheel lathes weighs some 62 tons.

Supply Position of Chromic Acid

ACCORDING to a statement by the British Non-Ferrous Metals Research Association, at the present moment chromic acid is in extremely short supply, and it is estimated that it will probably be three months before supplies become normal. Electro-platers may therefore have to face a period of this order in which they will be unable to get sufficient supplies of chromic acid to maintain their solutions at the normal working strength. In the first place, firms are therefore urged not to order in excess of their requirements. Since it is hoped that supplies will shortly become normal, it is obvious that any firms which now endeavour to increase their stock over that required to run the solutions will be tying up material which others urgently need. When supplies become normal, however, firms would be well advised to build up a small buffer stock.

In order to tide over the present emergency, the following suggestions are put forward :—

Care should be taken not to lose chromic acid by drag-out. Most chromium plants have a drag-out tank installed, in which the article is rinsed immediately after leaving the chromium solution. If such a tank is not available, it should be installed at once—a plain steel tank is suitable. The chromium tank is always made up from the drag-out tank and not by the use of plain water.

Under no circumstances should chromium solution be discarded. If for any reason the solution is not working satisfactorily, it should be adjusted to the correct value. If the solution is high in trivalent chromium and iron, this difficulty can usually be overcome by working for some time with a number of clean anodes and a small steel cathode, or, if available, a

porous pot on the cathode bar. The latter arrangement prevents the deposition of chromium and therefore further conserves the chromic acid.

If supplies of chromic acid are no longer available for making up, either the level of the tank or the concentration of the chromic acid in the solution, or both, must be reduced in order to keep the plant working. The average chromium solution works at about 4–4½ lb per gallon, but it is quite possible to work the solution down to 1 lb of chromic acid, provided that the sulphate ratio is adjusted to the normal value. As chromic acid is worked out of the solution, therefore, it is necessary to remove the equivalent amount of sulphate in order that the solution should function satisfactorily. Th s may be done by one of three methods :—

(*a*) The addition of freshly precipitated barium chromate. A solution of barium chloride is made and a quantity of chromic acid (or bichromate) added. This precipitates barium chromate, which, on standing, settles to the bottom of the vessel. The liquor is then poured off the precipitate, the vessel filled with water, shaken up and again allowed to settle, and the liquor poured off. This process should be repeated twice and the precipitate can then be added to the chromic acid bath, stirred up and allowed to settle.

(*b*) A somewhat simpler method is to add barium hydroxide directly to the plating solution, stir it in and allow to settle. This forms barium chromate in the solution, which precipitates the sulphate as barium sulphate.

(*c*) Calcium hydroxide or Vienna lime may be used instead of barium hydroxide.

It is not possible to estimate exactly how much sulphate will be precipitated by the addition of these reagents, as the reaction is not entirely quantitative, a certain amount of the barium or calcium being precipitated as chromate. It is suggested that about 1 lb of barium salts are taken to 100 gallons of solution. The operation is best carried out at the week-end, so that the solution may have plenty of time to settle out. After the reaction is complete, a test should be taken to ascertain the amount of sulphate, and if it has been reduced to below the optimum, an addition of sulphuric acid may be made to correct it.

Chromic acid should not be used for the dipping of brass and copper until supplies become normal. Chromic acid is manufactured from bichromate, and therefore it is also desirable to conserve supplies of bichromate as far as possible. Where other dipping agents can be used they, should be substituted for these. If this is impossible, then sodium bichromate and sulphuric acid may be used for the chromic acid dip.

Experimental Restaurant Cars on the L.M.S.

A NUMBER of innovations and improvements have been incorporated in two experimental restaurant cars shortly to be placed in service by the London, Midland and Scottish Railway Company between London and Wolverhampton and London and Manchester. Not only do the new cars have improved lighting, heating and ventilation but, as can be seen from the photograph we reproduce below, their general arrangement and seating accommodation has been vastly improved. A high standard of furnishing and decoration has been adopted and the new seating arrangements, together with the elimination of the usual partition, gives a sense of spaciousness and a greater freedom of movement.

The two cars, which were remodelled at the Derby works from an existing vestibule car and a restaurant car, embody the same general principles of layout and equipment. The vestibule car, which is illustrated, will seat 42 passengers, and the restaurant kitchen car 24 passengers. The vestibule car dining compartment is just over 49ft long, whilst that of the other car is nearly 30ft long.

INTERIOR OF VESTIBULE DINING CAR

The seating plan conforms to that of a normal restaurant car, one side of the coach being fitted with small tables seating two, and the other with larger tables seating four. All of the single seats at the small tables and the double seats against the doorways are fixed, but the remaining seats are movable chairs. The use of movable chairs instead of fixed seats in the new vehicles affords a great increase in spaciousness and freedom of movement. Not only can passengers on the window side leave the tables without disturbing passengers in the chairs on the gangway side, but individual service by the attendants is facilitated. The tables are supported on tubular members extending from brackets in the car sides, and a single pedestal near the outer extremity. Rubber pads are interposed between the table tops and the supporting members to reduce the effects of vibration.

A considerably improved form of lighting has been obtained by the use of a new design of ceiling lamp, for overall illumination, in conjunction with table lights fitted to the underside of the luggage rack in the vestibule car, and in the continuous pelmet which houses the curtain runners in the kitchen car.

By placing the steam heating pipes for the heating system in the body sides, instead of in a projecting skirting, some 3in of floor space has been gained on each side of the cars. Metal grilles, through which warm air is circulated under each table, are set flush in the sides of the body.

Ceiling ventilation of an entirely new type has been adopted, and for it the ceiling centre along the length of the coaches has been dropped slightly to provide an air space. This air space is divided into a series of concealed air ducts, through which used air is drawn by extractor ventilators on the exterior of the roof.

Double glazing has been adopted for all windows and ventilator lights in the dining compartments. The consequent reduction in loss of heat from the large area of glass in the cars has eliminated condensation and reduced the amount of heat needed to warm the coaches. The cold current of air which is reflected from normal windows and ventilator-lights has been avoided, and condensation between the two panes of glass is prevented by the use of absorbent material in the enclosed air space.

We understand that these cars are the forerunners of a series of five third and five first-class cars which will be brought into use as soon as practicable.

Electrode for Welding Pressure Vessels

INCREASING attention has been paid in recent years to the X-ray examination of welds for many purposes ; in particular, welded pressure vessels constructed to Lloyd's Class 1 requirements or the APPI-ASMI code are subjected to very thorough inspection. Every inch of weld is examined radiographically and must be substantially free from porosity and slag inclusions. The choice for this class of work has hitherto been limited to a few electrodes of American origin.

Particular interest therefore attaches to the production by Murex Welding Processes, Ltd., of its type "P.V." electrode, which is claimed to be the first all-British arc welding electrode designed specifically for pressure vessel welding. In addition to a high standard of radiographic cleanliness, the weld deposits have good mechanical properties, as shown by the following average results obtained on a number of all-weld specimens made with No. 6 gauge and ¼in diameter electrodes.

Yield Point...	... ...	24·2 tons per square inch.
Ultimate Stress	... ...	29·9 " " " "
Elongation on 1½in	...	31·4 per cent
Reduction of Area	...	50·6 " "

These all-weld specimens were machined out of U and V butt welds in ¾in boiler quality steel, and tested after stress relieving at 600 deg. Cent. Specimens from the same butt welds were subjected to Izod and bend tests, with the following results :—Izod : Notch at centre of top face of weld, 55 foot-pounds ; notch at junction of top face of weld, 41 foot-pounds. Bends : All specimens bent 180 deg over a 3 T former.

The type "P.V." electrode is designed specially for ease of running in the downhand position in deep groove multi-run welds, and is available in various gauges to suit all plate thicknesses. It is suitable for both d.c. (60 V open circuit) and a.c. (80–100 V open circuit) supplies, but d.c. supply is recommended for superior radiographic results.

Although it is primarily intended for pressure vessel welding, the electrode can advantageously be used in work which is to be vitreous enamelled or for vacuum tight equipment. Technical information on current values, plate preparation, storage and welding techniques appertaining to this electrode can be obtained from the manufacturer, Murex Welding Processes, Ltd., Waltham Cross, Herts.

An Automatic Internal Grinding Machine

A NUMBER of new features are incorporated in an automatic sizing internal grinding machine which has recently been introduced for mass-production work by the Churchill Machine Tool Company, Ltd., of Broadheath, near Man-

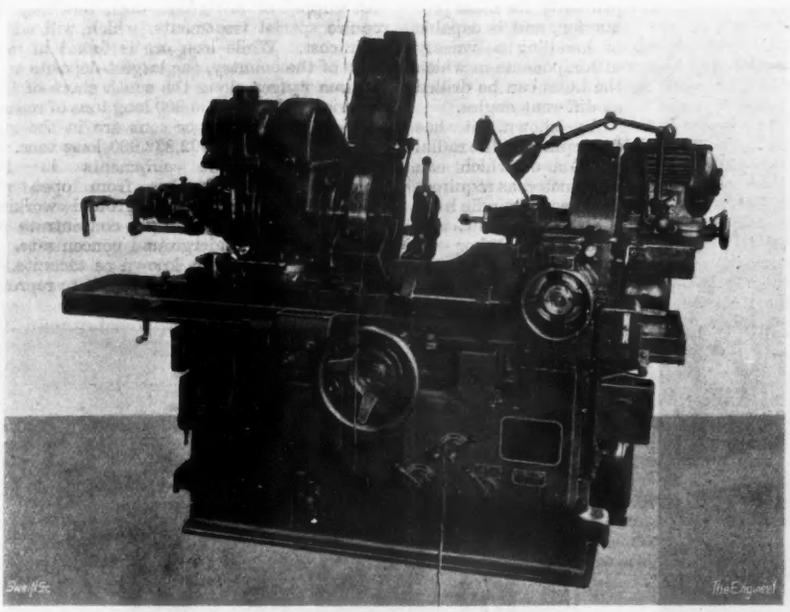
chester. This machine has a maximum swing of 12in inside the guard and 18½in over the table, whilst holes up to 12in long can be finish ground on it.

The table traverse of the machine has independent hydraulic speed control for the wheel truing and grinding operations, together with high independent run-in and run-out speeds. An automatic hydraulic feed to the wheel spindle slide is designed to give a suitable rate of cross feed with short table traverse, and the machine can be set for a short reversing stroke when grinding short and blind holes. Universal tables make possible quick and easy re-alignment and permits the grinding of long taper bores. The machine, which is illustrated below, works on a double cycle, the grinding of the work being divided into a roughing and a finishing operation, between which the wheel is automatically trued.

After the machine has been set the cycle of operations is started by the engagement of the hydraulic power traverse and movement of the hand reverse lever to start the table moving to the right towards the wheel spindle. The initial speed of the table is 35ft per minute and during this movement a truing dog first depresses the truing speed throttle valve. At this stage a mechanical locking device comes into effect and no reduction of table speed takes place until a second dog contacts the grinding traverse valve control lever. This lever is connected to a butterfly valve set at the outlet to the main hydraulic valve. Movement of this butterfly valve causes a reduction of the table traverse speed for the actual grinding operation, and at the same time a link withdraws a plunger, which releases the drive to the auto-cycle for the spindle feed cam motion. As the table oscillates to and fro during the grinding operation, a hydraulic connection from the pilot valve operates a small piston, which in turn oscillates the feed lever actuating the automatic cross feed to the wheel spindle slide.

This combined oscillation of the table and cross feed continues until a roughing peak on the feed cam is reached. The wheel spindle slide then drops back, due to the effect of a depression in the cam. Simultaneously, electrical contacts inside the feed box energise a solenoid coupled to the table reverse lever, which withdraws a plunger in the lever clear of the path of the reversing dog and allows the table to run out at 35ft per minute to the dead-stop position. This completes the roughing cycle.

The hand reverse lever is again moved to the right and the table commences to run in towards the wheel for the finish grinding cycle. Before the work reaches it the wheel is trued, automatic compensating feed to the spindle slide being put on mechanically before the wheel truing position is reached. As this truing position is reached the truing dog on the table depresses a roller lever coupled to an auxiliary valve in the main valve body, which causes the escaping oil to be partly throttled and slow down the table traverse speed. Simultaneously a diamond truing device is swung down by hydraulic power to pass across and true the wheel. Immediately the truing dog is passed the table speeds up again to its original speed of 35ft per minute until the grinding dog comes into effect, when the table is again slowed down to oscillate during the finish grinding. As the grinding oscillation commences, the automatic cam feed again comes into operation and continues until a sizing peak on the cam is reached, followed by a brief dwell period to build up finish. When finish grinding is completed the wheel spindle slide drops back whilst the work is withdrawn from the wheel.



AUTOMATIC INTERNAL GRINDING MACHINE

The reverse lever solenoid is again energised to withdraw its plunger and the table runs out to the dead-stop position.

At the conclusion of the grinding cycle the work rotation is stopped, the water supply cut off and the component is ready to be removed from the chuck or fixture.

The diamond truing speed and the grinding traverse speeds may be varied by adjustment of small hydraulic valves controlled by the ball-handled levers on the front cover. As these adjustments are entirely independent of each other they do not affect the maximum speed of table traverse; it is possible to obtain an infinitely variable series of conditions of truing and grinding speeds. Hand motion is only used for the setting of the machine, all motions being fully automatic after this initial setting.

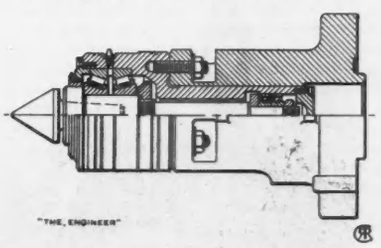
In view of the fact that the grinding feed is entirely automatic and controlled by the contour of a cam, it is especially important that the wheel slide should be sensitive to the slightest variation in setting. For this reason the wheel slide is relieved of the weight of the spindle drive and is mounted on accurately ground slides with an efficient system of lubrication. The motor driving the wheel spindle is mounted on a roller slide and is connected to the wheel slide by a link bar, which allows the motor to follow the movement of the wheel without putting a load on its slide.

The work head spindle is mounted in dual ball thrust and journal bearings and is arranged for four work speed changes through an endless vee belt drive. The work head is carried on a swivel base, allowing for the swivelling of the head up to 30 deg. towards the operator and full provision is made for the fitting of various types of chucks or fixtures to the spindle nose to suit the type of work to be ground.

A Live Centre for Turret Lathes

A NEW live centre, introduced by Austin and Lang, Ltd., Gunite House, Great West Road, Brentford, Middlesex, has been specially developed for use on turret lathes. This centre, a drawing of which is reproduced below, is designed to combine rigidity and strength with consistent working accuracy.

The centre is attached to the turret by a cast iron extension holder of the usual type. In order that the initial true setting of the centre shall not be affected by inaccuracies of the turret face, four pads are ground on the holder, and these are checked by means of a dial indicator to ensure its correct alignment. The centre housing is hardened and ground all over, and its shank is made an accurate fit in the extension holder. It is attached to the holder by means of three clamping studs, the nuts of which set in recesses formed in the holder. The flange on the housing from which the studs project is thus rigidly held to the extension holder. This method of flange mounting serves to relieve the stresses normally imposed upon the neck of the housing shank when heavy components are being supported or heavy cuts are being taken on the lathe.



PRECISION ROTATING CENTRE

The spindle of the centre is mounted on opposed preloaded roller bearings at the head, and opposed independently preloaded angular contact ball bearings at the tail end. A range of interchangeable centre inserts is available. All centres are ground in position with the spindle running in its own bearings. Centre re-grinding is done by the user in his own works and for this purpose a driving spindle can be screwed on to the tail end of the spindle.

A Miniature Machine Shop

A SMALL exhibition was recently held by Armand Dutry and Co. (ADECO), Ltd., 47, Lowndes Square, London, S.W.1, to introduce a miniature workshop this firm has just placed on the market. The workshop at present contains three machines in miniature form—a drilling machine, a pedestal grinder and a circular saw bench—and we understand that other machines will be introduced in due course. It is intended for use as a practical educational medium for the young, but as the machines are designed as working replicas of the originals they can also be used for small instrument and model-making purposes.

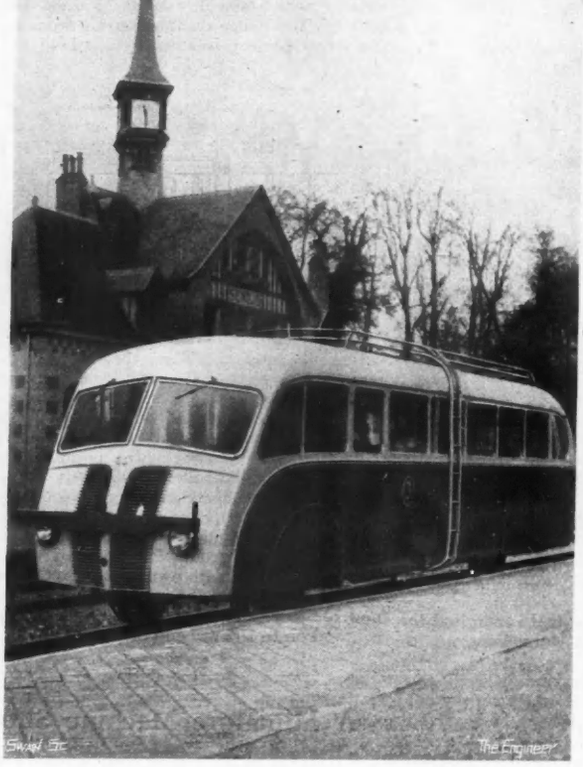
The bodies of the machines are moulded from plastic material, with the shafts, chucks, bearings, &c., of metal. In the standard miniature workshop the machines are belt driven from a main shaft driven from a fractional horsepower motor. If it is so required, the machines can be supplied as individual working units mounted on a common base with a small driving motor.

The drilling machine, which has an overall height of 6½in, has a three-speed pulley to give a top speed of 1500 r.p.m. Its chuck

can accommodate drills from 0·020in to 0·055in diameter, and wood, thin steel and brass up to $\frac{1}{16}$in thick can be drilled with ease on this machine. The pedestal grinder has twin wheels, $\frac{3}{4}$in diameter, $\frac{1}{4}$in wide, which are supplied in three grades. It is some 3in high and its shaft speed is about 2000 r.p.m. The circular saw bench table is $2\frac{3}{4}$in high and the machine takes a miniature steel saw $1\frac{1}{2}$in diameter, rotating at 2000 r.p.m. It is designed to cut wood up to $\frac{5}{16}$in thick or thin sheet metal.

French "Autorail" Cars

FOLLOWING heavy demands on the S.N.C.F. for small branch lines, hitherto used exclusively for goods traffic, to be opened to passenger traffic, the State railways have come out in favour of the "autorail" as a solution to the problem. These vehicles are a light type of rail-car, of between 80 h.p. and 150 h.p., adapted from road passenger vehicles already produced in quantity.



FLOIRAT VEHICLE ADAPTED FOR RAILWAY USE

Two makes of vehicle, the Floirat and F.N.C., were tested before final decisions were made. The first-named is simply a modified road vehicle. Although up to now this solution had presented certain disadvantages, it can now be presented in a more favourable light, thanks to the reliability of modern metal vehicles. Also, it is relatively cheap, owing to the use of group production methods.

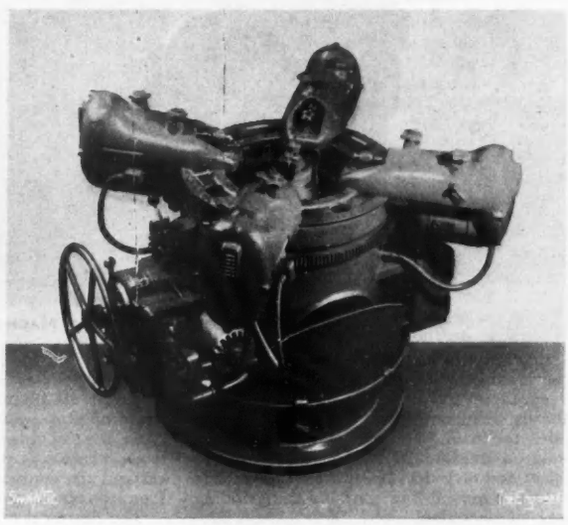
The second type, the F.N.C. "autorail," is constructed with two axles and has a capacity comparable to that of a railway carriage. In addition to specific railway equipment, several parts, such as engines, gearboxes, &c., were specially designed for it. Tests on the F.N.C. were made later than those on the Floirat vehicle, which has been running on the line between Senlis and Crepy-en-Valois, recently.

The Floirat is stated to have the following specification: Metal bodywork with doors on each side; a Bernard diesel engine; a back wheel track very similar to that of the railway gauge; capacity equal to forty seats, and compressed air brakes. The necessary modifications were therefore reduced to replacing the swivelling front axle by a fixed axle, and exchanging rubber tyre wheels for wheels with steel rims. Couplings and electricity connections were also added so that trailers could be used if necessary in the future. The modified vehicle is illustrated in the accompanying engraving.

A Multi-Spindle Drilling Machine

THE photograph reproduced below shows a new multi-spindle, radially adjustable drilling machine, which has been designed by Adcock and Shipley, Ltd., of Leicester, for the purpose of drilling holes in differential spiders for tractors. This machine has been designed primarily for mass production, and is capable of handling a variety of components in which the holes can be drilled at different angles.

As shown, it has four spindles, the radial position of which can be adjusted as required. Since each spindle head is a separate unit, any required number of heads up to eight can be fitted on the machine.



MULTI-SPINDLE DRILLING MACHINE

The base of the machine consists of a substantial cylindrical box casting having a large central opening, and round the top of which is a circular slide carrying the drill spindle saddles. In the centre of the machine bed is a round platform on which is mounted an interchangeable, air-operated fixture for holding the components. Swarf which accumulates in the interior of the base is removed through a large opening in the side. A chip tray, which surrounds the bed, has in it drains through which the coolant is returned to a reservoir enclosed in the base.

Each of the drill saddles is an independent unit driven by its own $\frac{1}{2}$ h.p. flange-mounted motor. The spindles are driven through vee belts at 915 r.p.m. Three-jaw chucks on the spindles hold the drills and variation of drill length is effected by adjustable arbors on the spindles.

The drill spindles, which have a maximum traverse of $5\frac{1}{2}$in, are fed either by hand or automatic means through a common mechanism mounted on the front of the machine. Hand feed is effected by turning the large hand wheel, whilst the automatic feed mechanism, which is engaged by movement of a small lever, is driven by a separate motor. Three changes of automatic feed rate are provided through a gearbox at the side of which is a feed selector lever. An adjustable depth trip is used for variation of the extent of drill penetration into the work.

American Iron Ore Resources

WITH the very high production of iron and steel in the United States, and the ever-increasing consumption, there is a serious question as to the remaining quantity of iron ore. A large proportion of the high-grade ores is gone, and there is a steady drain on the resources of medium-quality ores. There is a vast supply of low-grade ores, but they will require special treatments, which will add to their cost. While iron ore is found in many parts of the country, the largest deposits are in the iron ranges along the south shore of Lake Superior. Of 1,203,235,000 long tons of reserves in these ranges, 82 per cent are in the great Mesabi range, with 992,832,000 long tons. Of this volume, the shipments in 1945 included 42,706,000 tons from open pits, 1,646,000 tons from underground workings, 13,790,000 tons of open-pit concentrate and 143,000 tons of underground concentrate. As to the low-grade rock, known as taconite, the deposits are said in a recent report to represent "scores of billions of tons," or possibly an amount "almost astronomical" if further exploration is carried on. Magnetic taconite must be mined, crushed, ground to less than 100-mesh size and then concentrated to produce a low-silica concentrate, which must in turn be agglomerated before it can be charged into the blast-furnace. To make such operations economical, they must be carried on in large plants, where every advantage is taken of the possibilities of cost reduction. The establishment of such plants is still for the future, but such a development is under consideration by some of the steel companies which own the taconite deposits. A possible alternative is the discovery and development of rich ores in other countries, and explorations are under way in Cuba, Labrador, South America and elsewhere. But the economical development of the known taconite ores would have the advantage of giving the United States an almost inexhaustible supply within its own borders.

Canadian Engineering Notes

Magnesium Plant Starts Operation

Arvida, in the Saguenay district of Northern Quebec is fast becoming one of the outstanding metal-producing centres of the world. Since 1926 it has been the home of the Arvida Works of the Aluminum Company of Canada, Limited, the largest plant of its kind in the world, and a few months ago the American Zinc, Lead and Smelting Company announced its decision to form an 11,000,000 dollar corporation to operate a zinc smelter at Arvida, also. Quite recently the Aluminum Company announced that its new magnesium plant, also in Arvida, had started operation. The new plant has a capacity of 1000 tons of metal per year, and is so designed that it can be readily expanded as the demand increases. The process used is the electrolysis of magnesium chloride, which is made from magnesium oxide. The company has been interested in magnesium since 1915, when it participated in the first Canadian production of the metal at Shawinigan Falls. At that time it was a comparatively rare and high-priced metal, used mainly in powdered form for photographic flashlights, flares, tracer bullets, and similar purposes. However, the Shawinigan magnesium plant proved to be uneconomical, mainly for lack of suitable raw material, and it was dismantled in 1919. About that time heat-treatable alloys made their appearance, which derived their remarkable strength and hardness from small quantities of added magnesium or other alloying elements. Such alloys were first produced by the company at Toronto, and later at Kingston, using purchased magnesium. During the second World War the company started fabrication of magnesium alloys, mainly for Canada's aircraft requirements. Such products as magnesium alloy die, permanent mould and sand castings, rod, bar, sheet and forgings can be made at the Etobicoke and Kingston plants of the company from the metal produced at Arvida. Magnesium oxide is produced at the company's plant at Wakefield, in the Gatineau district, north of Ottawa, using the Gatineau Valley brucite deposits. During and since the war, magnesium oxide from the Wakefield plant has been supplied to the refractory industry, which was previously dependent on overseas sources for meterial of similar grade.

Steel Hopper Wagons

The purchase of 150 covered steel hopper wagons, the first of a new type to be ordered by the Canadian National Railways, has been announced. They will be built by the National Steel Car Corporation at Hamilton, Ontario. They will weigh 70 tons and will be of all-steel construction, with capacity for a total rail-load of 105 tons. Each car will have eight 3ft square hatches for loading and four 1ft 1in by 2ft discharge gates, with special equipment for vibrators to loosen and speed the unloading of its cargo. The wagon is suitable for such commodities as lime, cement, sulphur, silica sand, crude abrasives, and other like products. In the past these supplies had to be packaged to be handled in box cars or they had to be carried loose in open cars, unprotected from the elements.

Newfoundland Power

With a view to determining water power possibilities, the Newfoundland Government has decided to conduct a survey of its great lake-dotted terrain and it has appointed a Canadian to handle the job. The survey will be conducted by G. H. Desbarats, honours graduate of McGill University, and a member of the Electrical Institute of Canada. At present two large power developments are in operation—on the Exploits River on the north side, which provides hydro-electric power for the newsprint plant of the Anglo-Newfoundland Development Company at Grand Falls, and on the Grand Lake-Humber system on the west, used by the Bowater-Newfoundland Company in the newsprint and pulp mills at Corner Brook. In addition, the Newfoundland Light and Power Company utilises lake and river systems in the south-eastern Avalon peninsula to light St. Johns and to provide power to operate the tramways and industrial plants. The Avalon Telephone Company, with its affiliated United Towns Electric Company, develops hydro-electric power in the peninsula for the telephone system, to provide light and power in the suburbs and to supply the iron mines on Bell Island. Untapped as yet are the famous Grand Falls on the Hamilton River in Labrador. It is understood the Government survey will take in this territory. An indication of the little value formerly placed upon water power was the granting to a private concern of rights to Muskrat Falls—a great hydro potential on the Hamilton—for thirty dollars a year.

Increased Industrial Activity

Described by the Minister as "a document of great importance," a report tabled recently in the House of Commons by Reconstruction Minister Howe, shows that Canadian business enterprise is planning, in 1947, to invest an aggregate capital of 1,700,000,000 dollars, or 53 per cent more than the comparable outlay for 1946. The report was prepared by the economic research branch of the Department of Reconstruction, following a survey of 12,000 Canadian firms. Tabled at the same time was a second report forecasting the production intentions of producers of the principal basic and building materials. The surveys indicate that while some of the capital outlay now envisaged may not be realised during the year, the magnitude of the programme is certain to involve an increased portion of the nation's productive facilities and contribute accordingly to the maintenance of a high level of employment and income. Groups covered by the survey included manufacturing, mining and all forms of utilities and construction.

Welding Bureau

A new Division of the Canadian Standards Association has recently come into operation on the formation of the Canadian Welding Bureau. The Canadian Standards Association undertook this work on the urgent request of a wide section of the welding and fabricating industry. One of its principal functions will be to ensure good welding by approving shops, engineering and supervisory personnel and operators. The basis of qualification will be the welding codes and specifications prepared by the Canadian Standards Association. The Association will progressively prepare and issue codes covering the whole welding field, and this will avoid a costly multiplicity of standards and specifications, which has already developed in some countries. The Bureau has recognised that the existence of codes is not in itself sufficient to ensure good welding. For this reason and to satisfy all users and potential users of welding, approval by the Bureau is granted only to those fabricators whose welding equipment, operators, supervisory and engineering personnel satisfy the standards under which the Bureau operates. Lists of such approved members are now in the course of preparation. The Bureau's engineering personnel is at present engaged in testing and according approval under arc welding standards. Codes are projected for resistance welding, gas welding and brazing.

Navigational Aids

Canada plans to build two low-frequency, long-range radar stations in the far north this summer as aids to aerial and marine navigation, and it is possible a third will be constructed in 1948. The stations will be operated in conjunction with others on United States territory, presumably Alaska. It is announced that American aid in technical personnel has been offered until sufficient trained Canadian personnel are available for replacement. The Government has also decided to extend existing navigational aids to increase safety of air and sea travel by the establishment of low-frequency "Loran" stations in the north. Low-frequency Loran is considered the best available method for meeting the requirements of the rapidly increasing world airways traffic and has been recommended by the Provisional International Civil Air Organisation as the standard aid to long-range navigation.

New Chemical Plants

Dow Chemical Company of Canada, Ltd., recently concluded negotiations with Polymer Corporation, the Crown synthetic rubber project at Sarnia, Ontario, to purchase approximately 54 acres of plant site. With this acquisition, the chemical concern now owns approximately 160 acres of industrial property at this location. With the construction of a new plant for the manufacture of polystyrene practically completed, ground has now been broken for a second large plant. This will be for the production of glycol, the anti-freeze material, and will cost approximately 2,500,000 dollars. The new plant is designed to produce Canada's entire requirements of ethylene glycol and, in addition, will produce smaller quantities of ethylene dichloride diethylene glycol and triethylene glycol. The glycol plant alone will cover about 5 acres of ground. Within the plant will be housed some 10 miles of pipe of various sizes, and nearly 8 miles of electric conduit. In addition to several buildings, there will be many fractionating towers, the tallest of which will be 85ft. A third major unit at Sarnia is also projected for the immediate future. This is a plant to produce methyl chloride as the principal item, but it will also produce lesser quantities of methylene chloride, chloroform and carbon tetrachloride and hydrochloric acid. The Dow methyl chloride plant will use as its two principal raw materials methane and chlorine. The methane will be abstracted from local natural or refinery gas. Chlorine will be obtained from Ontario chlorine producers. The plant is to be compact and will occupy a small area relatively. Because of the abundant use of instrumentation, it will operate almost automatically. The process calls for extremes in temperature in order to produce finished products of high purity. In the process the gas passes through a temperature range of 750 deg.

New Railway Line

A start is to be made shortly by the Canadian National Railways on a line that eventually is intended to bring the mining area of Chibougamau, Quebec, much better transportation facilities than have existed heretofore. Tenders are being called for construction of 39 miles of the first section from Barraute to Kiask Falls, on Bell River, in the Abitibi district. A Bill was passed at the last session of the Quebec Parliament authorising expenditures on this line to the amount of 4,125,000 dollars. It is intended later that this single-track line will be extended some 110 miles into the Chibougamau district. Relatively large sums of money have been expended in development work in the Chibougamau area. There are some small power sites in this area, but a considerable amount will be required to develop them. This may be carried out in due course by the Quebec Hydro-Electric Commission.

New Power Plant

Announcement has been made by James Wilson, president of the Shawinigan Water and Power Company, that as soon as the necessary governmental authorisations can be secured, his company will proceed vigorously with the construction of a new and third powerhouse in the gorge at the foot of Shawinigan Falls, to house three 65,000 h.p. hydro-electric units. This new 195,000 h.p. plant will enable the company to secure a greatly increased and more dependable output from its Shawinigan Falls stations. The work, which will be carried out by the Shawinigan Engineering Company, Ltd., is timed for completion early in the autumn of 1948, and will cost about 12,500,000 dollars. A new roadway on company property is under construction to furnish access to the location of the new power-house. Construction machinery and building materials are being rushed to the site of the new project so that work can be got under way immediately the governmental approvals are obtained.

Industrial and Labour Notes

Craft Unions and Time and Motion Study

The General Federation of Trade Unions, which represents a number of craft unions in various industries, recently appointed a sub-committee to inquire into time and motion studies, with particular reference to their physical and psychological effect on workpeople. The Federation has now issued this sub-committee's report, which suggests that full advantage should be taken of time and motion study in order to increase production and lessen fatigue, but proposes that it should be employed in consultation with the trade unions to avoid suspicions of exploitation.

The report says that motion and time studies comprise two distinct though closely related functions. In theory, it might be held that motion study had no connection with time study, but under peacetime conditions motion study often becomes the basis of time study and in those circumstances cannot be divorced from it. Dealing specifically with time study, the report comments that it is reputed to determine the period of time that an average worker should require to perform an operation, working at normal speed under set conditions, the purpose being to establish such standard time as a basis for paying workers according to their output. It also assesses contingencies occurring during the performance of the job which should be paid for in addition to the rate allowed for the job itself. According to the report, the trade union view on this question of timing in connection with wage fixing is that an agreed hourly or weekly wage should be guaranteed and piecework prices fixed so as to enable a worker of average ability to earn a given percentage above the hourly or weekly day time wage. This wage, it is suggested, is a matter for negotiation with the employer by union officials.

Commenting that workers seem to regard with suspicion any attempt to impose either motion or time studies, the report expresses the opinion that where the application of scientific methods of production can be proved to be of advantage to industry generally and to the workers employed, they should be welcomed. If it is necessary to introduce motion and time study schemes, the report concludes, it is of the utmost importance that the workers and their trade union representatives should be consulted at all stages.

Industrial Negotiations

The Minister of Labour said in Parliament last week that he was continuing his examination of the machinery for negotiation in industrial disputes, with a view to its improvement. In reply to a question as to whether he would consider a general inquiry into the whole system, the Minister said that he did not think such an inquiry would be very helpful. There were about fifty wages councils which were being consulted collectively, and he was meeting their chairmen. He hoped that the information obtained would be considered shortly by the National Joint Advisory Council.

Working Hours

An enquiry was made last Autumn by the Ministry of Labour to obtain particulars of the average weekly earnings and working hours of manual wage earners employed in the manufacturing industries generally, and in some of the principal non-manufacturing industries—such as mining, transport, public utility services and Government industrial establishments—of the United Kingdom. The information related in all cases to the last pay-week in October, 1946, and the returns asked for were made by about 51,500 establishments.

The statistics which were collected during the enquiry have now been summarised by the Ministry of Labour and reveal that in most industries the average hours worked by men in the last pay-week of October, 1946, ranged between 44 and 50, those worked by youths ranged between 43 and 47, while those worked by women and girls were generally between 40 and 45. For all the main industries taken together, the hours worked in the last week of October, 1946, averaged approximately 47¼ for men, 44¾ for youths and boys, and 42⅓ for women and girls. As compared with the hours worked in the last week of October, 1938, these averages showed little change in the case of men, but for youths and boys, there was a reduction of about 1½ hours; for women a reduction of nearly one hour, and for girls a reduction of approximately two hours.

The Ministry of Labour proposes in future to conduct two of these enquiries a year, one in the Spring and the other in the Autumn.

Lord McGowan on Labour Problems

In his chairman's statement, presented at the annual meeting of Imperial Chemical Industries, Ltd., on May 8th, Lord McGowan commented on the expansion of his company's labour force, the increase of output per man-year, and the proper distribution of labour.

He said that, with the object of increasing output per man-year, the I.C.I. would continue its plans for more extensive mechanisation and the adoption of automatic plant-control. The company's adoption of the "Training Within Industry" scheme, and its education programme, would assist, Lord McGowan thought, in furthering the economic and effective use of labour. He went on to stress the contribution which employers could make to the solution of the labour problem by schemes such as those mentioned and by ensuring that there was full co-operation between managements and employees. The Government had stated the problems, and it was for industry to do its part in ensuring that labour and materials were used to the best advantage.

Trade Disputes

The latest figures published by the Ministry of Labour relating to trade disputes show that, in the month of March, 159 disputes leading to stoppages of work were reported. In addition, twelve stoppages which began before March were still in progress in the early part of that month. In these 171 stoppages, 52,000 workers were directly and indirectly involved, and it is estimated that, in the aggregate, about 112,000 working days were lost.

There were eighty-seven stoppages in the coal-mining industry in progress at some time during March, involving 10,400 workers and causing an aggregate loss of 13,000 working days. In the metal engineering and shipbuilding industries, fifty-two stoppages were in progress, involving 26,700 people and causing a loss of 42,000 working days.

Now that the figures for March have been issued, it is possible to compare the extent of industrial stoppages in the first quarters of this year and last. During the first three months of this year, there were 459 stoppages of work through disputes, involving altogether 165,500 people, and resulting in an aggregate loss of 682,000 working days. In the first quarter of 1946, there were 588 stoppages in progress, in which 130,000 people were involved and which caused a loss of 577,000 working days.

Foremen and Increased Output

The Association of Supervisors' Discussion Groups is organising a one-day conference on "Foremen and Increased Output," which will take place at the Central Hall, Westminster, S.W.1, on Saturday, May 31st, from 9.45 a.m. to 6 p.m.

The conference will be opened by Mr. C. G. Renold, and during the morning an address entitled "Why Work?" will be given by Lord Forrester, managing director of Enfield Cables, Ltd. In the afternoon, Lieut.-Colonel R. A. C. Radcliffe will speak on "Leadership on the Shop Floor," and Miss I. F. Hilton will deal with the subject of "Women in Industry." There will be open discussion after all the addresses.

The Association of Supervisors' Discussion Groups began with two experimental groups in the London area. Its aims are to provide a means of link-up between groups, to provide for the exchange of information, experience and advice on group activities, and to promote and advise on the formation of supervisors' discussion groups. It organises conferences at suitable intervals for foremen and supervisors and also keeps in touch with Government departments and other bodies on matters affecting foremanship and supervision, and endeavours to encourage activities likely to promote the professional education of foremen and supervisors. The honorary secretary of the Association is Mr. W. M. Dawson, 80, Valley Road, Welwyn Garden City, Herts.

The London Chamber of Commerce

The annual general meeting of the London Chamber of Commerce was held on Friday last, and in the course of his address, Sir Frank Newson-Smith, who was re-elected President, spoke of the importance of achieving balance between production of capital and consumer goods. He said that the production of capital goods would benefit the consumers of the future, but the men employed on that production were the would-be consumers of to-day, and if they were to be kept strong, healthy and in good heart for their work, their present needs must be reasonably satisfied.

Sir Frank went on to point out that balance was the essence of sound international trading. All our new schemes for international trade and international payments should, he claimed, be based upon first achieving, and then maintaining balance. International loans were not a substitute for a balance between the goods and services provided to the world and those received from it. At best they were expedients to gain time in which to achieve that balance, but if they were allowed to go on mounting up they would themselves make the attainment of that objective more difficult or even impossible. If the lender was not prepared to take payment in the only possible manner, namely, in excess imports, the attainment of balance was impossible in any case. His conviction was that unless and until the nations were prepared to accept, as a fundamental basis of all their schemes, that international trade was and could be nothing but an exchange of goods and services between the nations—certainly on a multilateral basis—all the schemes which were now being discussed would prove illusory and disappointing.

Raw Material Supplies

Another survey of raw material supplies in this country has been made recently by *The Board of Trade Journal*. Amongst other matters, it emphasises the acute shortage of steel, saying that for a time the ordinary consumer will feel the effect of the loss of production caused by the fuel crisis and of the priority recently accorded to certain items of basic industrial equipment.

Dealing with non-ferrous metals, the survey says that copper and aluminium are in relatively free supply, although the use of the latter is limited by fabricating capacity. Zinc is rather less assured, but should suffice for all important needs. Tin remains in world short supply and exportable surpluses are, of course, subject to international allocation. There is some limitation to its usage in the United Kingdom, but most requirements, despite their tendency to rise, should be adequately covered by the output of domestic smelters. The one serious non-ferrous shortage is of lead, and no appreciable improvement is in prospect, notwithstanding the high prices now ruling.

French Engineering News

(From our French Correspondent)

PARIS, May 9th

At least a 30 per cent increase in electricity prices is expected in France, following the revelation that members of the administrative council of Electricité de France have asked the Prime Minister to take steps to make good the budgetary deficit. The Minister of Finance has definitely refused any suggestion of subsidy and the deficit will have to be borne by consumers. Last July, the deficit was estimated at 18 milliard francs. Since then there has been a 50 per cent rise in tariffs, but the deficit is said to have doubled. Wages have not changed since that period, nor have conditions of sale altered, and nationalisation is popularly supposed to be responsible for the situation. Electricité de France states that the original rise in tariffs was insufficient.

* * *

The exports committee of the Ministry of National Economy has approved the 1947 export plan by which supplementary allocations of raw materials, mainly metallurgical products, will be supplied to exporting industries. Exports are not only important because they supply the foreign currency for imports of coal and wheat, but also because countries in the French Union, such as Madagascar, are urgently demanding machinery, lack of which is holding up progress in agriculture, mining, transport, &c. It is contended, however, that the quarterly allocation of 170,000 tons of steel for the export of manufactured goods will not be fully used, mainly owing to French prices, which are too high, and also because manufacturers find it more profitable to work for the home market. It is therefore suggested that a minimum percentage of goods to be produced for export might be imposed, even if it does not bring large profits, in order to keep France's place on foreign markets open.

* * *

Speaking of the reconstruction of the French merchant fleet, Monsieur Jean Marie, President of the Compagnie Générale Transatlantique, has stated as his opinion that the two-thirds of the commercial fleet to be reconstituted should maintain equilibrium between liners and cargo boats, the one complementing rather than replacing the other. He divulged the fact that the construction of two fast liners for the Central America and Antilles line had been decided on, as well as two others for Mediterranean service and one to serve the Moroccan coast. Together with the "Ile de France," reconverted to serve the Havre and New York line, the "Liberté" and the "De Grasse," France would be able to resume her former place. As for the "Liberty" ships, Monsieur Marie thought that they presented grave drawbacks. Although they solved the quantity problem, supplying the tonnage necessary, they did not solve the problem of quality. However, they were an important aid while awaiting the construction of cargo vessels suitable for the diverse transport problems existing.

* * *

A union of machine tool reconstructors has been formed, marking a further effort to solve the problem of supplying industry with the machine tools it needs, despite continued high demands compared with possibilities of being able to satisfy them. It is agreed that maximum national production and imports cannot fill the gaps, and industrialists are overhauling and modernising the machinery they have, where they cannot obtain new machines. This solution is particularly important at a time when the country is suffering from lack of foreign currency and shortage of raw materials. Compared with the purchase of a new French machine, reconstruction takes only a small proportion of the iron and steel which would be required. Compared with the purchase of a foreign machine, the saving in foreign currency is considerable. Finally, in spite of the costs of reconstruction and even admitting that final output is inferior to that of more modern machines, there is still an economy in capital invested.

Notes and Memoranda

Rail and Road

RAILWAY RECEIPTS.—Traffic receipts of Great Britain's four main line railways and the London Passenger Transport Board for the four weeks ended April 20th, totalled £25,859,000 compared with £27,310,000 in the same period of 1946.

MOTOR VEHICLE REGISTRATIONS.—The number of private motor cars registered in Great Britain in February was 7385, which included 547 surplus Government vehicles. In the same month, total registrations of goods vehicles were 8081, including 2311 surplus Government units.

ROAD CONDITIONS IN AUSTRIA.—Examination of roads in the British zone of Austria after the great thaw which followed the hardest winter on record showed that fifty-three bridges were damaged by frost and floods. It is reported, however, that in general the state of roads and bridges is better than was expected. All repairs required are being put in hand and are being supervised by the British authorities.

LEICESTER SQUARE UNDERGROUND STATION.—London Transport states that a new passage is now being constructed between the Northern Line platforms and the Piccadilly Line platforms at Leicester Square Station to improve the passenger interchange between the two lines. At present, interchange is by means of the original lift passages at the south end of the Northern Line platforms and the west end of the Piccadilly Line platforms. The new passage will give direct connection between the lower escalator landing of the Piccadilly Line and both platforms of the Northern Line at a central position. It will be a straight circular tunnel, 100 yards long. To break the monotony of a straight passage, it is being constructed in various diameters, sections of 12ft, 12ft 6in, and 15ft being introduced. It will be lighted by fluorescent lighting in accordance with the new standard now being introduced at more important stations in Central London. The work of construction includes not only the driving of the new passage tunnel, but also the removal of part of the tunnel lining of the running tunnels of the Northern Line where it passes under the southbound line in a subway to give access to both platforms. To carry out the work with minimum interference to the public, a working shaft, 100ft deep, is first being sunk from street level in Upper St. Martin's Lane. By means of this shaft, all the excavated material and the new material required for construction will be moved from and to the works. It is expected that the work will be completed by the end of the year.

Air and Water

LAUNCH OF LIGHT FLEET CARRIER, H.M.S. "ALBION."—On May 6th the new light fleet carrier H.M.S. "Albion" was launched from the Wallsend Shipyard of Swan, Hunter and Wigham Richardson, Ltd. The naming ceremony was performed by Mrs. Attlee, the wife of the Prime Minister. In design and construction, the new carrier follows exactly her sister vessel, H.M.S. "Centaur," which was described in our issue of May 2nd. The geared turbine machinery for the propulsion of the "Albion" was built by Swan, Hunter's associated company the Wallsend Slipway and Engineering Company, Ltd., and it embodies the latest practice.

Miscellanea

SCHOLARSHIPS.—Two scholarships for the study of mechanical engineering at an approved university are being offered annually by Davy and United Engineering Company, Ltd., and its associated companies. Full details and application forms for this year's scholarships may be obtained from the Personnel Officer, Park Iron Works, Sheffield, 4.

THE PRESENTATION OF TECHNICAL INFORMATION.—The University of London announces that Professor R. O. Kapp's course of four lectures on "The Presentation of Technical Information" is to be repeated on Mondays, June 2nd, 9th, 16th and 23rd, at 5.30 p.m. They will be delivered at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, W.C.2.

INCREASED TIN PREMIUM.—The Ministry of Supply announces that as from May 5th, the premium for English refined tin of 99·9 per cent minimum quality, as sold by the Directorate of Non-Ferrous Metals, has been increased from £3 10s. per ton to £5 10s. per ton. The customary extra of 10s. per ton for 28 lb ingots continues to apply. Further enquiries should be addressed to the Directorate of Non-Ferrous Metals, 20, Albert Street, Rugby.

ENGINEERING AND METALCRAFT EXHIBITION.—Some sixty-five firms are represented at the Engineering and Metalcraft Exhibition, which opened at the Royal Horticultural Hall, Westminster, London, S.W.1, on Monday, May 12th. This Exhibition will remain open daily from 9.30 a.m. to 8.30 p.m. until Friday, May 23rd. The object of the Exhibition is to show that British firms are not only producing goods of quality at competitive prices, but also lead the world in design, developments and inventiveness.

TUNGSTEN ORE.—The Ministry of Supply announces that the price of tungsten ore of standard grade, from Government stocks, is now 115s. per unit of WO_3, delivered consumers' works. For special high grade Scheelite to the following specification: WO_3 minimum 68 per cent, tin maximum 0·60 per cent, arsenic maximum 0·10 per cent, molybdenum maximum 0·10 per cent, the price is 120s. per unit WO_3, delivered consumers' works. Any enquiry should be addressed to Ministry of Supply (M2), Shell Mex House, Strand, London, W.C.2.

HEAVY ELECTRICAL PLANT COMMITTEE.—The Ministry of Supply has announced the reconstitution of the Heavy Electrical Plant Committee under the chairmanship of the Minister. Plant manufacturers are represented on the Committee, as well as the Central Electricity Board and the North of Scotland Hydro-Electric Board, various Ministries and the appropriate trade unions. The Committee will serve as a medium for advice and co-ordination of the Ministries and organisations concerned, and will act as a steering body for increasing and accelerating the output of heavy electrical plant for home generating stations.

BRITISH BUSINESS INTERESTS IN JAPAN.—It was announced in Parliament recently that the Board of Trade is compiling a limited list of representatives of British business interests to go to Japan in due course as a preliminary to the resumption of private trade. Although no final decisions have been taken nor dates fixed, firms who are interested in sending a representative should register particulars immediately with the Board, as arrangements may have to be made at short notice. Details should be sent to the Board of Trade, 35, Old Queen Street, London, S.W.1. It is expected that the British quota will include representatives of banking, insurance and shipping, as well as merchanting and business interests.

SCIENTIFIC ADVISORY COUNCIL.—The Ministry of Supply announces the following appointments to the Minister's Advisory Council on Scientific Research and Technical Development which advises on the important scientific and technical problems with which the Ministry is concerned:—Professor Wesley Austin, Goldsmith's Professor of Metallurgy in the University of Cambridge; Professor W. E. Curtis, F.R.S., Professor of Physics at King's College, Newcastle; Lord Hankey, F.R.S.; Professor Willis Jackson, Professor of Electrical Engineering at the Imperial College of Science and Technology, London; Professor E. K. Rideal, F.R.S., Fullerian Professor of Chemistry at the Royal Institution of Great Britain; and Mr. S. Robson, of the Imperial Smelting Corporation of Bristol.

INSTITUTION OF STRUCTURAL ENGINEERS.—The annual dinner of the Institution of Structural Engineers, with the President of the Institution, Professor H. J. Collins, in the chair, was held on Thursday of last week, May 8th, at Grosvenor House, W.1. The function was well attended by members, guests and their ladies, the company totalling well over 400. Speeches were made by Professor Collins, Viscount Bennett, the Earl of Athlone, and Mr. W. K. Wallace (Vice-President of the Institution), and were followed by dancing to midnight. Viscount Bennett said that he came from a continent where structural engineering was very dear to the hearts of the people. Even in Canada they had built skyscrapers and had almost made themselves bankrupt in imitating their neighbours. He was greatly concerned about the present position of Great Britain and the vast sums which she owed everywhere. Professor Collins, replying, controverted assumptions that this country had no fight in it. It was the policy of the Council to get back to pre-war conditions. Mr. Wallace welcomed the guests, whilst the Earl of Athlone, in replying, said that it was extraordinary how many engineers were absorbed in the world. With regard to the University of London, University College required much reconstruction, but would eventually house a fine college for engineering students. He declared that London had been the centre of the business world and would be again, and he thought that Great Britain would return to her former position.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

"Britain's Best" Engineering and Metalcraft Exhibition

Monday, May 12th to Friday, May 23rd.—London, Royal Horticultural Hall, Westminster, S.W.1.

British Industries Fair

To-day, May 16th.—London, Olympia and Earls Court; Birmingham, Engineering and Hardware Section, Castle Bromwich, Birmingham.

Chemical Engineering Group

Wednesday, May 28th.—Waldorf Hotel, Aldwych, W.C.2. Annual general meeting and dinner. 5.30 p.m.

Institute of Economic Engineering

To-day, May 16th.—Cowdray Hall, W.1. "Practical Problems of Production Control." A. W. Willsmore. 7 p.m.

Institute of Fuel

Wednesday, May 28th.—Geological Society, Burlington House, Piccadilly, W.1. "Combustion and Combustion Equipment for Aero Gas Turbines," E. A. Watson and J. S. Clarke. 2.30 p.m.

Institute of Metals

Wednesday, May 21st.—Institution of Civil Engineers, Great George Street, S.W.1. "Metallurgical Problems Involved in the Generation of Useful Power from Atomic Energy," Sir Wallace Akers. 6 p.m.

Institution of Civil Engineers

To-day, May 16th.—YORKSHIRE ASSOCIATION: Great Northern Station Hotel, Leeds. Annual general meeting. 7.15 p.m.

Tuesday, May 20th.—Great George Street, S.W.1. "Model Experiments in Relation to Harbours and Waterways," J. Allen. 5.30 p.m.

Institution of Electrical Engineers

Saturday, May 17th.—N. MIDLAND STUDENTS: Leeds Electricity Department, Whitehall Road, Leeds. Luncheon and annual general meeting. 2.30 p.m.

Institution of Production Engineers

Monday, May 19th.—DERBY SUB-SECTION: Art School, Green Lane, Derby. "Lay-Out of Factory and Plant for Efficient Production," S. Gilbert. 6.45 p.m.

Saturday, May 31st.—YORKSHIRE GRADUATES: Visit to David Brown Tractors, Ltd., Meltham. 2.30 p.m.

Iron and Steel Institute

To-day, May 16th—Annual Meeting in London. For programme, see page 367, April 25th.

North-Western Fuel Luncheon Club

Wednesday, May 21st.—Engineers' Club, Albert Square, Manchester. "Fuel Quality and Efficiency," A. Parkes. 12.30 p.m.

Royal Institution of Chartered Surveyors

Monday, June 2nd.—12, Great George Street, S.W.1. Annual general meeting. 5 p.m.

Royal Meteorological Society

Wednesday, May 21st.—49, Cromwell Road, South Kensington, S.W. "The Problem of Diffusion in the Lower Atmosphere," O. G. Sutton; and "A Microclimatological Investigation of Bath and the Surrounding District," W. G. V. Balchin and N. Pye. 5 p.m.

Stephenson Locomotive Society

Saturday, May 17th.—SCOTTISH CENTRE: L.M.S. Offices, 302, Buchanan Street, Glasgow. "West Highland Wanderings," J. B. Aird. 3 p.m.

Saturday, May 24th.—SCOTTISH CENTRE: Visit to North British Locomotive Co., Hyde Park, Glasgow. 2.30 p.m.

Saturday, May 31st.—Visit to Crewe Works and Sheds, L.M.S.R. 9.30 a.m. and 2.30 p.m.—Visit to Eastleigh Running Shed, S.R. 3.30 p.m.

Women's Engineering Society

To-day, May 16th.—35, Grosvenor Place, S.W.1. "Women in Post-War Engineering." 7 p.m.

Catalogues

B. DIXON-BATE, Ltd., Chester.—Catalogue on the "D-B" two-wheel trailers.

CRODA, Ltd., Snaith, Goole, Yorkshire.—Illustrated booklet on rust preventatives.

ALFRED HERBERT, Ltd., Coventry.—Illustrated booklet dealing with threading equipment.

Ioco, Ltd., Anniesland, Glasgow, W.3.—Booklet detailing Ioco insulating products.

BROOM AND WADE, Ltd., High Wycombe.—Catalogue on sleeve-valve portable air compressors.

ALAR, Ltd., 35, New Broad Street, E.C.2.—Folder of Alar data sheets of aluminium casting alloys.

PETER BROTHERHOOD, Ltd., Peterborough.—Publication No. B.R.S. 46, on Ricardo diesel engines.

HADFIELDS, Ltd., East Hecla Works, Sheffield.—Illustrated catalogue No. 466, on steel castings.

CLYDE CRANE AND BOOTH, Ltd., Union Crane Works, Rodley, Leeds.—Illustrated brochure on cranes.

FAIREY AVIATION COMPANY, Ltd., Hayes, Middlesex.—Leaflet describing the "Fairey" toggle fastener.

Personal and Business

MR. JAMES MITCHELL has been appointed a director of Stewarts and Lloyds, Ltd.

MR. E. J. BATCHELOR has been appointed assistant managing director of Brush Coachwork, Ltd.

MR. R. J. COOPER has been elected a director of Manufacturing Services, Ltd., 3, The Cambray, Cheltenham.

STEEL CITY SUPPLY COMPANY, LTD., has moved to new premises known as Flameox and Arcweld Works, Savile Street East, Sheffield, 4.

MR. JOHN THOMPSON has been appointed mechanical engineer of the Northern Counties Committee, London, Midland and Scottish Railway, in succession to the late Mr. Malcom Patrick.

THE GLOBE PNEUMATIC ENGINEERING COMPANY, LTD., has transferred its head office to 58, Victoria Street, London S.W.1. (Telephone, Victoria 9122; telegrams, "Pneumatoid, Sowest, London").

MR. T. SALTER, A.M.I. Mech. E., has been appointed Midland Engineer of Heenan and Froude, Ltd., in succession to Mr. E. C. Coney, who has been promoted to another position on the company's staff.

DR. T. SETTLE, M.I.E.E., has retired from the post of manager of the industrial heating and carbon departments of the General Electric Company, Ltd. He has been in the company's service for the past thirty-nine years.

THE MINISTER OF SUPPLY has appointed Sir Charles McLaren, K.C.B., as official chairman of the Gauge and Tool Advisory Council in succession to Mr. S. F. Steward, C.B.E., who has resigned in order to devote his full time to his business interests.

SHILLAN'S ENGINEERING COMPANY, LTD., has removed from Banbury to works at Southport, where B.M.B. light tractors and implements will be produced. The home and export sales departments will continue to operate from Britannia House, Ampton Street, W.C.1.

THE NORTHERN ALUMINIUM COMPANY LTD., announces that its head executive office has been transferred from Banbury to Wellington House, Lancaster Place, Strand, W.C.2. The London sales office has also moved to the same address. (Telephone, Temple Bar 4433; telegrams, "Noraluco, Rand, London").

THE LONDON AND NORTH EASTERN RAILWAY COMPANY announces that consequent upon the resignation of Mr. J. Ratter, permanent way assistant to engineer, London, Mr. H. C. Orchard, has been appointed to succeed him. Mr. G. Crabtree has been appointed district superintendent, Edinburgh, in succession to Mr. G. M. Johnston, who is retiring.

COMMERCIAL TRANSOCEAN (LONDON) LTD., has been formed to represent, in the United Kingdom, the British Empire and Eire, the centralised Export Office of the French Aircraft Industry, and to act as buyer in England for French aircraft constructors. The directors are Mr. R. M. Wisner, M.I. Mech. E., and Mr. R. H. Pitchford, M.I. Mech. E., and Mr. M. M. Cansick is secretary and commercial manager. The offices of the company are at 4, Seamore Place, Park Lane, W.1. (Telephone Grosvenor 4293).

THE METROPOLITAN-VICKERS ELECTRICAL COMPANY, LTD., states that Mr. G. W. Alexander, A.M.I.E.E., has been placed in charge of the mining department in succession to Mr. H. Watson-Jones, who was recently appointed chief electrical and mechanical engineer to the North Western Division of the National Coal Board. Mr. E. Loynes, A.M.I.E.E., of the Metrovick mining department, has been appointed Divisional Electrical Engineer, North-Western Division of the National Coal Board.

THE EAGLE STAR INSURANCE COMPANY, LTD., (ENGINEERING DEPARTMENT) and G.P.U., Ltd., including the Electroplant Company and its associates have agreed to co-operate in a comprehensive service scheme on plant and machinery. The technical survey staff of the Eagle Star will be available in connection with the varied activities of the G.P.U. Group, the latter having arranged to increase its engineering services in respect of inspection survey, valuation, maintenance and hire-purchase. All G.P.U. services are now combined under the management of Mr. H. S. Lewis, A.M.I. Mech. E., at 56, Victoria Street, London, S.W.1.

NON-FERROUS SCRAP.—The Ministry of Supply states that the stock of non-ferrous scrap metals on charge on March 31st was 47,842 tons. Sales for the two-month period, February and March, amounted to 10,907 tons, valued at approximately £655,000.

Reports on German and Japanese Industry

Limited numbers of copies of the reports of Intelligence Objectives Sub-Committees on German and Japanese Industry listed below can be obtained from H.M Stationery Office at the prices stated.

No. of report.	Title.	Post free. s. d.
F.I.A.T.:		
290	Wire Programme Services of the Reichspost	1 7
295	Lithium Extraction and Uses ...	3 2
354, 355, 356, 357, 358, 359, 360	German Photo-Sensitive Products Manufacture	13 3
389	Veneer and Plywood Manufacturing Techniques and Machinery Observed in Western Germany	4 2
481	Coke and Nitrogen Fertiliser Plant: Reichswerke Hermann Goering A.G. Linz, Austria ...	3 8
621	Fuel Injection Without Injection Pump	1 7
750	Rare and Minor Metals	2 2
782	The Production of Dense, Non-Porous Bronze Castings	2 2
849	English Translation of "Developing Uses for the Distillation Residues from Butadiene Obtained by the Reppe Synthesis" ...	1 1
C.I.O.S.:		
XXXIII–1 ...	Visits to C.P.V.A. (Danish Nienhof) and Harburger Gummiwaren-Fabrik Phœnix: Research in the Testing and Bonding of Rubber	9 3
B.I.O.S.:		
449	German Medical Targets: German Reports with Abstract in English	28 0
580	Report on Tests of the Wagner Boiler Conpany with a Model Boiler	11 9
658	German Photographic Industry...	8 9
690	Prevention of Atmospheric Pollution by Noxious or Offensive Gases, Fumes or Dusts	5 2
695	The Design and Operation of German Telephone Exchange Equipment	7 2
718	Milling of Barley and Oats in Germany	3 8
771	Specifications and Testing of Oils, Fuels and Lubricants in Germany	20 5
798	The German Ferro-Alloy Industry	8 9
866	High-Frequency Heating	3 2
879	Manufacture of Wool Felt, Fur Felt and Velour Hoods, Hats and Capelines in Germany ...	2 2
974	Alumina and Aluminium Production at the Lippewerk of the Vereinigte Aluminium-Werke A.G. Luenen	3 2
975	Alumina Production at Martinswerke Bergheim/Rhineland ...	1 1
980 (Part II)	Electro-Acoustics in Germany ...	1 1
1035	Metallgesellschaft A.G. and Lurgi Bau, Frankfurt-am-Main Electrostatic Separation of Coal and Other Minerals	6 2
1067	The German Protein Hydrolysis Industry: Manufacture of Flavouring Materials and Amino-Acid Preparations	2 8
1072	Report on Fruit Plant Nurseries and Fruit Research Stations in Western Germany and the German Official Fruit Plant Certification Scheme...	2 1
1074	The Manufacture of 0·22 Rimfire Ammunition and Other Products by Dynamit A.G. at Nurnberg and Stadeln	3 2
1079	Rubber Chemicals: Interrogation of Dr. Casper, of I.G. Leverkusen...	1 7
1081	Silicon Tetrachloride and Related Products: Silicones, Silicic Acid Esters, Finely Divided Silica (K3)	3 8
1098	Design and Performance of the Steyr V.8 Air-Cooled Automobile Engine	9 3
1112	Forging and Heat Treatment Technique at Some Major German Factories	6 8
1121	Manufacture of Paint Driers and other Metallic Soaps in Germany	4 2
1129	The German Accumulator Industry	5 8
1131	Report on Investigations in Germany on Slag Cements and Lightweight Concrete	5 2
1140	Barium Compounds and Lithopone Industry in Germany ...	3 2
F.I.A.T.:		
889	Metallurgical and Industrial Developments in Magnesium ...	7 2

B.I.O.S. Information Section, 37, Bryanston Square, W.1., which has at its disposal a considerable volume of information not in a form suitable for general reproduction, is prepared to receive enquiries regarding all problems relating to scientific and technical intelligence on both German and Japanese industry.

A Seven-Day Journal

Northern Ireland's Industries

In order to assist industries in Northern Ireland with scientific and technical problems, the Northern Ireland Ministry of Commerce has formed a scientific development branch. The Ministry's intention in taking this step is to encourage the widest adoption of scientific and technical research methods by industry, and to promote a closer relationship between industry and pure and applied science. It is also proposed to set up an information service which will provide local industry with scientific and technical advice on its many problems. It is explained that the scientific development branch will establish and maintain close contact with the universities, the Department of Scientific and Industrial Research, Trade Research Associations and similar bodies, both in the United Kingdom and overseas, thus providing industries in Northern Ireland with the latest available information in the field of scientific and industrial research. The director of the scientific development branch is Mr. A. J. Howard, 20, College Gardens, Belfast.

F.B.I. Research Conference in Sheffield

The Federation of British Industries is continuing its series of regional conferences on industrial research on Thursday, June 5th, when a one-day meeting will be held at the Royal Victoria Hotel, Sheffield. The beginning of Sheffield industries and the part research takes in solving their contemporary problems will be described at the conference. The morning session which opens at 10 a.m. will be presided over by Sir Walter Benton Jones, and will be devoted to a consideration of "Research and Economic Recovery." Papers will be presented on "Research and National Recovery," by Sir William Larke, "The Historical Growth and Economic Development of Sheffield Industries," by Dr. G. P. Jones, and "Industrial Problems of the Sheffield Area and their Solution by Methods of Research," by Professor R. J. Sarjant. The afternoon session at 2 p.m. will deal with "The Industrial Approach to Research." Lord Dudley Gordon will preside and the papers to be presented are: "Sheffield Research Organisations, Facilities and Activities," by Dr. W. J. Rees, and "The Smaller Firm and Its Application of Research," by Dr. F. L. Lea. Each session will be followed by an open discussion and at the end of the day the proceedings of the conference will be summed up by Sir Charles Goodeve, Director of the British Iron and Steel Research Association. Full particulars of the conference can be obtained from the F.B.I. Sheffield Office, 2, Wharncliffe Villas, Sunny Bank, Sheffield, 10.

The Use of Oil in the Gas Industry

Speaking at a luncheon at the British Industries Fair, Birmingham, on Thursday of last week, May 15th, Mr. J. R. W. Alexander, general manager of the British Gas Council, referred to the increasing use of oil for gas-making in order to save coal. This, he said, had been done at the request of the Government, despite the fact that the costs of production were appreciably higher and that for every ton of coal not carbonised, half a ton of coke was lost to the market. During the last three years, the gas industry had raised its consumption of oil by 110 per cent, and during the current year this figure would be increased to 190 per cent. This meant, Mr. Alexander continued, that gasworks would save 6,250,000 tons of coal this year by using instead no less than 216,000,000 gallons of oil. In addition to this, the Government asked the gas industry during the fuel crisis to reduce the amount of coal carbonised by 10 per cent during the ten weeks ended May 10th, and the response was such that a reduction of 12 per cent had been effected, representing a saving of 625,000 tons of coal. Mr. Alexander went on to explain that whilst, as a matter of expediency, the substitution of oil for coal for gas-making materially decreased the gas industry's demand for coal, it must not be overlooked that the fuel economy of the country would not be restored until full use was made of the nation's coal resources. In considering, therefore, the amount of coal which should be mined, regard must be paid not only to the immediate needs based upon the continued use of substituted fuels but to the real coal requirements of the country, both for internal use and export. If this consideration was associated with the established fact that true coal conservation could only be secured by the carbonisation or gasification of all suitable coal, then the re-establishment of the industrial prosperity of the nation would be assured.

London's Water Consumption

At a meeting of the Metropolitan Water Board on Friday last, May 16th, Mr. Hugh Franklin, chairman of the Works and Stores Committee, made a statement regarding a proposal to conduct a campaign for a reduction in water consumption in the Board's area. He explained that there was no shortage of water in the rivers or the springs, and after the heavy rains and snowfall of the winter it was anticipated that there would be an ample supply of water available for the Board's purposes. There were also adequate mains and pumping machinery for the distribution of water, but the bottle-neck at present was in the Board's filtration plant. The average daily supply in 1938–39, Mr. Franklin said, was 313,000,000 gallons, but for 1946–47 it was 332,000,000 gallons. At the rate at which the supply was now being afforded it was anticipated that in the year 1947–48 it would exceed the figure of 350,000,000 gallons a day. The consumption of water per head had risen from 43·8 gallons a day pre-war to 52 gallons a day at present, and the Board was now faced with a supply position which had not been anticipated until 1954. The shortage in filtration plant, Mr. Franklin continued, was known in 1941, and although on the previous trend of increase in supply it was confidently predicted that the plant available would be sufficient until 1954, plans were prepared for a considerable extension of filtration stations, and had the war not intervened those stations would have been in commission by now. Mr. Franklin went on to intimate that an average water consumption of 350,000,000 gallons a day portended many consecutive days in the summer period when there would be a higher demand, possibly reaching 450,000,000 gallons a day. The capacity of the Board's filtration plant and direct supply wells was limited to 360,000,000 gallons a day, so that any balance would have to be supplied from the 290,000,000 gallon reserve in the filtered water reservoirs, which, however, were not evenly distributed throughout the Board's area. Unless, therefore, there was a considerable reduction in the daily water consumption, there would be a shortage of supply, especially on high ground, which would have to be supplemented by a system of tank wagon distribution, such as was put into force during the flooding at Lee Bridge.

The World Power Conference

We have just received the annual report of the World Power Conference for 1946, which is the first annual report to be published since the report of 1939. Copies of the report can be obtained from Mr. C. H. Gray, Secretary of the International Executive Council at the Central Office, 201–2, Grand Buildings, Trafalgar Square, London, W.C.2. Sir Harold Hartley, the Chairman of the International Executive Council of the World Power Conference has just received a letter from Mr. Trygve Lie, the Secretary-General of the United Nations, informing him that the Economic and Social Council of the United Nations has adopted a resolution granting consultative status to the World Power Conference. The Conference, it is pointed out, is the first international body in the engineering field to receive this status. Further reports on fuel economy since 1939 are now coming forward, and five reports concerning Argentina, Australia, Austria, Czechoslovakia and Germany are now available as preparatory material in connection with the forthcoming Fuel Economy Conference of the World Power Conference, which is to be held in The Hague, Holland, from September 2nd to the 9th, 1947. The Argentine, Australian and Czechoslovakian reports have been prepared by the respective National Committees of the World Power Conference, the Austrian report was prepared by the Austrian Ministry of Trade and Reconstruction, while the German report was prepared under the auspices of the Allied Control Commission.

Factory Construction in the Development Areas

The second report of the Select Committee on Estimates, which was published early in the week by H.M. Stationery Office, deals with the administration of Development Areas. The committee says that it was impressed by the enterprise displayed in the Development Areas themselves, but that it is nevertheless concerned about the progress made in factory construction. The Board of Trade estimates that the total potential employment to be provided by the new factories now approved in the Development Areas is 149,100, but on March 31st last, employment had been provided for only 3251 people. The difficulties which have been caused by production and supply problems are appreciated by those responsible for the Development Areas programme and are the subject of constant inquiry and examination, and in particular, the report says, shortages of bricks and steel have seriously delayed the construction of new factory premises. It is suggested, however, that in order to overcome these delays, an undue reliance seems to have been placed on the appointment of progress officers, although while the supply of labour and materials is difficult, these officers are undoubtedly necessary and serve a valuable purpose. At the same time, the committee feels that their assistance is limited. The fact that they are employed both by the Board of Trade and by the Estate Companies must cause a duplication of effort, and the report suggests that a reduction in the number of progress officers might well be considered. The need is rather for decisions on a ministerial level to provide that the manufacturers of the basic materials for factory construction and industrial plant are enabled to maintain full production. All factory building schemes, the report continues, should be planned sufficiently far ahead to enable the Estate Companies to make bulk purchases of the requisite supplies of such materials as bricks, steel, timber and paint, and, at the same time, a definite programme for factory construction over a limited period should be agreed. The highest, if possible, exceptional, priority, should then be given for the materials required to complete the programme, and in order to avoid delay it is considered essential to have a phased programme of the supplies needed for the different factories under construction to ensure that steel and other materials in short supply are available when they are wanted. The report also calls attention to delays caused by the necessity for constantly referring various matters to headquarters for financial approval, and passes on a suggestion that a devolution of financial responsibility would aid more rapid decisions.

Sazillism: Its Origin and Evolution

By S. LELIAVSKY BEY

No. IV—(*Continued from page 418, May 16th*)

8.—Design Value of Small-scale Model Tests

CURIOUSLY enough, even so apparently a straightforward solution of the stress problem as that supplied by model tests is not foolproof in this case against concealed pitfalls and cases could be quoted in which experimental results that at the time of their publication had generally been accepted as a solid fact were later found open to well-founded doubts

Take, for instance, the method usually adopted for reproducing in the model the effect of the water-load in the prototype. Starting with the earliest elastic dam model test of the slab type, carried out by Mr. Mallock, in the end of 1904[16] this has always been done by applying a certain mechanically or hydraulically developed pressure to that part of the periphery of the elastic material which corresponds to the wetted surface of the masonry work and rock-foundation in the prototype.

For sake of greater clearness of exposition the principle will be found illustrated in Fig. 12, which shows the arrangement of the water-loads in the classical tests of Wilson and Gore,[17] and in the also rather well-known experiment of Karl Pearson.[17] In both cases, it will be observed, the horizontal and vertical hydraulic pressures are replaced by a system of weights applied either directly or by means of strings and plates to the surface of the elastic model representing the dam.

This, indeed, was characteristic of the older conception in which the action produced by the water on a masonry or concrete wall was visualised as a surface force, similar in a sense to that of an earth-pressure. Later, however, new ideas were put forward, tending, as they did, at undermining this rather too elementary approach; in fact, even in 1913, Fillunger showed that owing to the water filtering through the masonry, part, at least, of the total hydraulic force had to be considered as being transferred into the dam and to be regarded, therefore, as a body force; such, for instance, as gravity, electric and magnetic attractions, &c.[18] This new conception altered substantially the elastic conditions of the mathematical problem and called, consequently, for another arrangement of loads, representing, in the model, the effect of the water pressure.

It is, of course, true that at the time of its publication, the theory of Fillunger remained almost unknown to wide circles of the profession, but in a somewhat different form the same basic principle reappeared again in Hoffman's solution, in 1928,[19] and in Terzaghi's theory, of 1934.[20] Some years later the same point was, once again, taken up by Brahtz.[21]

Alterations necessary in the mechanical arrangements of tests in order to fall in with the new ideas on the subject must be considered separately for the horizontal pressure on the one hand and for vertical loads on the other.

Take, first, the horizontal action; here we have the so-called gradient line commonly used for representing graphically the intensity of the "uplift" pressure in an imaginary horizontal section of the dam. The slope of that line is a measure of the difference in the horizontal components of the internal hydrostatic pressures, acting on the opposite faces of a wall separating two adjacent pores. The steeper, therefore, that line, the greater the horizontal pressure transferred through the walls of the pores to the material of the dam.

The integral of the slope of the gradient diagram gives, obviously, the sum of these interstitial actions calculated over the entire width of the section; and since this integral is equivalent to the full hydraulic pressure which hitherto had been supposed to have been exerted upon the face of the dam, it may appear that the new ideas do not alter the mechanical conditions of the case. In fact, the bending moment and the shear for a horizontal section of the dam are the same in both cases, whether the horizontal water pressure be applied externally to the wetted periphery or interstitially to the walls of the pores. Thus, from a casual inspection, it seems that the old solution still remains valid.

This assumption, however, is not correct; while the normal stress on the horizontal planes (that is n_y) and the shearing stress ($t_x = t_y$) are not affected, the normal stress on the vertical planes (n_x) is substantially changed; and this cannot be allowed without introducing basic alterations into the boundary conditions of the integration problem of the elastic foundations. What

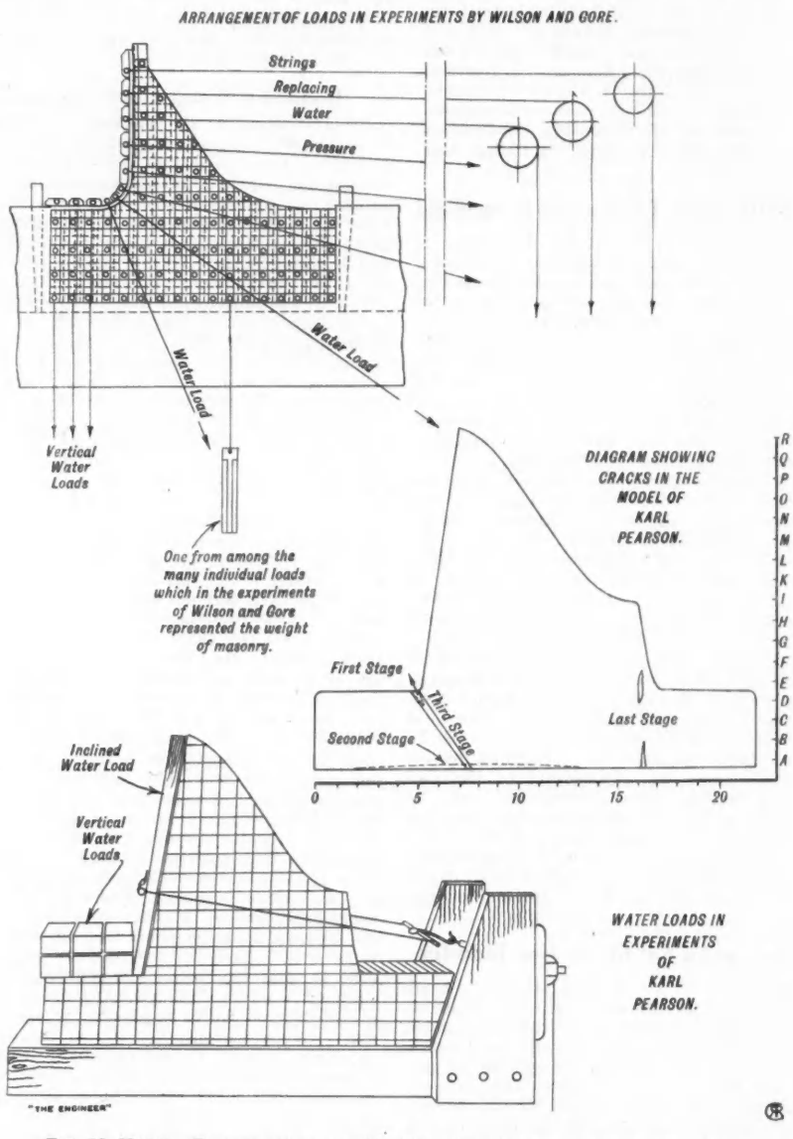

ARRANGEMENT OF LOADS IN EXPERIMENTS BY WILSON AND GORE.
Strings
Replacing
Water
Pressure
Water Load
Water Load
Vertical Water Loads
One from among the many individual loads which in the experiments of Wilson and Gore represented the weight of masonry.
DIAGRAM SHOWING CRACKS IN THE MODEL OF KARL PEARSON.
First Stage
Third Stage
Second Stage
Last Stage
R Q P O N M L K I H G F E D C B A
0 5 10 15 20
Inclined Water Load
Vertical Water Loads
WATER LOADS IN EXPERIMENTS OF KARL PEARSON.
"THE ENGINEER"

FIG. 12—Model Experiments of Wilson and Gore, and Karl Pearson

[16] This is the first model experiment of the elastic slab type known to the author. It was made, at the Aswan dam, on the suggestion of Sir Benjamin Baker, in connection with Atcherley and Pearson's theory, and is referred to by Mr. Mallock, in p. 85, "Proc." Inst. C.E., Vol. CLXXII. The author is not quite certain, however, whether this is the same experiment which is quoted by Sir Benjamin in his contribution on Coolgardie water supply, in the same "Proceedings," Vol. CLXII, p. 122.

[17] *Loc. cit.*

[18] "Der Auftrieb in Talsperren," "Oster. Woch. f. d. off. Baud.," 1913, N 31 to 34.

[19] "Permeazioni D'Aqua," Milano, 1928.

[20] "Die Wirksame Flachenporositat des Bétons," "Zeitschr. d. Ost. Ing. u. Arch. Ver," 1934, 1–2, p. 1..

[21] "Pressures Due to Percolating Water and Their Influence Upon Stresses in Hydraulic Structures," "Transactions" of the Second Congress on Large Dams, 1938.

should be done is, therefore, the following: instead of applying the pressure to the periphery of the elastic model, the strings coming from the counterweights representing the hydraulic load must be attached to the same pegs which, in the experiments of Wilson and Gore (see Fig. 12) were used for suspending the loads performing the function of the structural weight of the dam. What the result would have been in this case is a question that could be answered by tests alone. The fact remains, however, that the results, so far obtained, are not fully representative of the true conditions existing in Nature.

It follows, therefore, that elastic dam model tests of the slab type should preferably be conducted in two different ways, first, with the horizontal loading applied to the periphery of the elastic material, reproducing by these means the conditions occurring in Nature when the water in the reservoir rises rapidly and the material of the dam is still dry or partly so; and, secondly, using again exactly the same loads but distributing them over all the surface of the elastic slab, so as to show the state of the stress after sufficient time has elapsed for the water to have penetrated into the pores. Until this is done, no model test can be considered as covering the whole ground of the problem. Thus, the time factor creates here a new complication, which so far seems to have been overlooked[22].

Even more drastic alterations may, possibly, be required in connection with the vertical loads. In this case we are not only concerned with the point of application of the load but, as well, with its magnitude. The upward component of the pressure in the pores must necessarily reduce the effect of the structural weight upon the stresses in the dam, and this fact has to be taken into account in carrying out the test by a corresponding reduction in the vertical loads applied to the model. Here, again, we have to consider the rate of the rise of the water-level in the reservoir, repeating the test several times, with different arrangements of weights, until the whole range of stress variations, depending on the time-factor has been covered.

Little need be said to substantiate the validity of these suggestions, for they are believed to constitute in themselves a prima facie case; but another point, coming under almost the same heading, calls, perhaps, for a more elaborate demonstration; namely, that horizontal loads must not only be applied to the body of the dam but to its foundations as well. This, again, is a direct corollary to the new conception of the uplift pressure, but in addition to all other physical factors so far considered it introduces a new element: the ratio of the permeability coefficients for the dam and its foundation.

Let us begin by supposing that the material, of the dam is by far more permeable than the rock over which it is built; so that the latter, by comparison with the former, may be taken as fully watertight. In this particular case the arrangement of the loads used by Pearson (six bricks) to reproduce the effect of the vertical water-pressure on the rock surface upstream of the dam, though obviously crude, may possibly be accepted as an approximation to Nature. But consider now the much more frequent and probable condition when the general order of permeability of both materials is more or less the same. In this case, percolation of the water will not be confined to the dam alone, but will also be taking place in its foundations—a fact which is well-known to every practical dam engineer. That such an evident matter-of-fact contingency could have ever been lost sight of testifies, indeed, to a rather obvious excess of dogmatism in the basic assumptions of model experiments.

How far different are the conditions of the true problem from those implicitly accepted in the quoted tests will be clear from the three sketches in Fig. 13. The section reproduced in the upper part of this drawing shows the net of stream-lines and equipotential curves as computed by Hoffman, in 1928, in page 45 of his book. In the left-hand bottom corner the author has drawn the lines of equal pressures corresponding to Hoffman's curves, whilst in the third sketch he has indicated schematically the resultants of these pressures as they affect the statical problem of the dam foundation stresses.[23]

Comparing these forces with those in the tests of Wilson and Gore or Pearson, it is surprising to note the extent of the difference between the mechanical devices used in these models, and the nature of the physical conditions they were intended to portray; and yet, the experiments of Wilson and Gore are among the best that have ever been done and have repeatedly been quoted and reproduced, almost in full, as a standard for verifying the results of advanced mathematical analysis.[24]

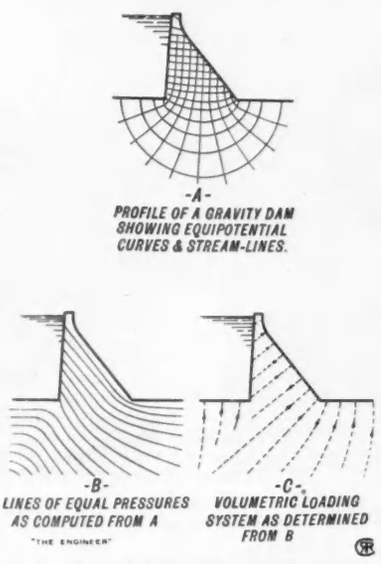

-A-
PROFILE OF A GRAVITY DAM SHOWING EQUIPOTENTIAL CURVES & STREAM-LINES.
-B-
LINES OF EQUAL PRESSURES AS COMPUTED FROM A
"THE ENGINEER"
-C-
VOLUMETRIC LOADING SYSTEM AS DETERMINED FROM B

FIG. 13—EQUIPOTENTIAL CURVES AND STREAM-LINES

It is interesting to mention in this connection that the authors of these tests were themselves the first to recognise the weak points in their experiments and stated so explicitly in the course of the discussion following their paper.[25] But, in spite of the criticism, the surprising fact is that the same arrangement has been used in the great majority of all subsequent tests. It shows that whatever the care in carrying out the tests and the ability—technical or analytical—of the experimenters, there is always the chance of a *lapsus* in recognising the fundamental principles underlying the general layout of the adopted testing device. The trouble lies, of course, in the rather fascinating effect which a close agreement between the results of such tests and pure theory is apt to produce on the experimenter, detracting, *ipso facto*, his attention from the obvious point that one may be as wrong as the other. This seems to be rather a more frequent occurrence than one would have expected under the circumstances.

Here, again, it must be emphasised that the author does not by any means intend to criticise the principle of model tests as such. These experiments can, and do, serve an extremely useful purpose in various branches of research work; it would, however, be erroneous to think that the weight of the evidence thus supplied could ever be compared to that obtained on actual works, since we cannot be entirely sure that the model is fully representative of the prototype; further developments in theory may show that the earlier conception of the observed phenomenon has been lacking in depth of insight.

Thus, from whatever point of view we consider Sazilly's principle, and the weight of the experience collected with it during a century of practical applications, it still remains valid as the starting point for both practical and theoretical approach; and whatever achievements have been reached in this branch of engineering mechanics, they should all be visualised as a development of this basic principle.

This must be made very clear to the "practical man" who cannot spend much time in analysing advanced mathematical investigations and might, therefore, easily be led to think that Sazilly's solution has been completely upset by modern research, so often referred to in various technical publications.

(To be continued)

FINNISH PATENTS.—The Board of Trade announces that it has issued a licence, under the Trading with the Enemy Act, 1939, authorising the payment to any person in Finland of fees due for the granting or renewal of any Finnish patent, design or trade mark, or any expenses in connection therewith, including the fees of patent agents. It will be necessary for persons remitting funds to Finland under the terms of this licence to comply with currency regulations, information in regard to which can be obtained from their bankers.

[22] In order not to complicate still further the exposition, we are neglecting here another consideration which must bear on the stress condition in the dam; that is to say, we are neglecting the problem of the "effective area" which was dealt with by the author in another paper.

[23] In order to convert a field of stream-lined fluid motion into that representing the effect produced by the moving fluid upon the pervious material through which it filters, we must know two constants: the effective superficial porosity and the effective volumetric porosity. The former is the ratio which the area subject to the interstitial pressure bears to the total area considered in the calculation of stress; the second coefficient gives the addition in the weight of the material due to the water it may absorb.

Had both constants been equal, the effect of the filtering water upon the stability of the dam might have been compared to that of a weightless liquid, and in determining its magnitude and direction we could have conveniently used the equipotential lines. This, however, is not the case. In a set of tests which is described by the author in another paper, he has found that the first coefficient averaged 0·91, whereas the mean value of the second factor was only about 0·07. Under such conditions the mechanical action exerted by the water upon the permeable strata can better be determined from the lines of equal pressures, as is done in Fig. 13.

[24] Cf. "Trans." Am. Soc. Civ. Eng., Vol. XGVI, p. 506; also "Proceedings" of the First Congress of Large Dams, Vol. V., p. 79; and many others.

[25] "The penetration of water, and its effect on the weight and stresses introduced a problem presenting many difficulties. Water passed completely through many dams, while others were perfectly dry on the downstream face. Experiments which had been made went to show that a water pressure acting on the face of a stone produced pressures of diminishing intensity for some distance from the face and in one experiment a sample of masonry seemed to have been burst by the action of water pressure on one face. In what way these effects altered the stresses in a dam it was difficult to estimate, and further experiments were needed ..." Min. of Proc., Inst. Civ. Eng., Vol. CLXXII, Session 1907–1908, Part II, p. 102. This abstract is believed to be particularly worthy of attention as it shows that already at this early period the authors of the quoted tests had an inkling of the true hydraulic conditions as affecting the stress problem, and were, therefore, five years ahead of Fillunger, who is usually supposed to have discovered the new principle in 1913. Which, of course, is another feather in their cap.

The British Industries Fair

No. IV—*(Continued from page 420, May 16th)*

IN the following article we continue our description of some of the exhibits at the Engineering and Hardware Section of the Fair, at Castle Bromwich, Birmingham.

Wilkinson Rubber Linatex, Ltd.

Two exhibits of particular interest on the stand of Wilkinson Rubber Linatex, Ltd., of Camberley, Surrey, were a centrifugal pump designed for handling sand, grit, chemicals, &c., and a ball mill.

A feature of the pumps, which have been designed in sizes ranging from 1in to 9in, is the shrouded impeller which is composed almost entirely of rubber. Nowhere in the pump is metal exposed to abrasive wear. A hydrostatic gland, of the maker's own design, consist of two circular Linatex rubber seals, each provided with feather edges on their inside diameter. These edges bear on a gun-metal sleeve fitted to the pump shaft. The gland water is supplied through a lantern ring, situated between the two seals. In operation the inner Linatex gland ring—that nearest the impeller—allows a small quantity of water to flow into the casing, but, in the event of surging or a momentary back pressure developing in excess of the gland water pressure, the gland ring closes down on the sleeve, thus preventing abrasive material from passing the ring.

The purpose of the outer gland ring is to prevent escape of gland water, but the gun-metal gland ring is adjusted to provide the slight seepage of water past the gland ring necessary for its lubrication.

The ball mill is designed to give all the abrasion-resisting advantages of rubber without using a bonded lining. It consists of a series of Linatex rings compressed together, and held immovably in place by tie rods embedded in the rubber itself. This design avoids all possibility of metallic contamination of the controls of the mill, and makes the mill particularly quiet in operation.

The firm exhibited two types of mill, the motor-driven self-contained unit illustrated in Fig. 22 and a composite roller drive model which possesses an advantage in that spare cylinders can be charged while the unit is running, and the detachable end allows for thorough cleaning, whilst the necessity for providing individual motors is obviated.

Strachan and Henshaw, Ltd.

On a site just outside the main building, Strachan and Henshaw, Ltd., of Bristol, erected one of its "Whitehall" rotary tipplers, designed for discharging main line mineral wagons varying in size and up to 21 tons' capacity. Complete with electrical driving gear, the tippler was demonstrated rotating a 16 tons' capacity railway wagon.

These tipplers are of the automatic clamping type, and when the wagon is in position and rotation begins, the gravitational clamping mechanism automatically takes charge and holds it firmly whilst it is being tipped.

The main cage of the tippler consists of two rings braced together to form a rigid structure. An L-shaped cradle, consisting of two joist members braced together, is connected to the cage by four sets of steel links which make the cradle capable of vertical movement relative to the normal position of the cage. Within the cradle is a rail table suspended from four sets of steel links which make the table capable of sideways motion relatively to the cradle. As the cage rotates, the relative movement of the cradle through the links first brings the wagon side to rest against pads on the vertical arms of the cradle. On further rotation, the cradle, complete with rail table and wagon, swings towards fixed stops attached to the top of the cage. Before the wagon has been rotated through 90 deg. it reaches the fixed top stops and remains in this position relatively to the cage during the remainder of the rotation.

The cage is supported on four cast steel rollers, two of which are driven and rotate it by frictional contact. A wagon in the tipped position can be seen in the photograph of a tippler reproduced in Fig. 23.

Electric Furnace Company, Ltd.

A variety of heat-treatment processes can be conveniently carried out in a compact form of electrode salt bath exhibited by Electric Furnace Company, Ltd.,161, Queen's Road, Weybridge, Surrey. This equipment, known as the Midget Efco Ajax-Hultgren electrode salt bath, is illustrated in Fig. 24, and is specially convenient for carrying out heat treatments in a small works or tool-room where the expense of larger and more expensive salt baths would not be justified. Cutters up to 3½in diameter and 4½in in length can be heat treated up to a maximum temperature of 1350 deg. Cent., the working dimensions of the bath being 4in diameter by 6in depth of salt. The bath is rated at 6kW and is suitable for connection through a step-down transformer to a 200/250V single-phase, 50 cycles supply.

The salt bath and the associated electrical gear are mounted in a robust welded mild steel framework to form a completely self-contained unit, occupying a floor space of approximately 3ft by 1ft 8in. All the electrical equipment is housed in a totally enclosed ventilated cubicle with removable covers at the back of the unit, giving access to the connections. The pot can be supplied either in metal or in refractory material, depending on the heat-treatment process. For example, a refractory lined pot is used for H.S.S. hardening and neutral hardening; a metal pot is used for carburising, tempering, nitriding, &c. Suitable insulating material surrounds the pot, and the whole assembly comprising the bath proper is contained in a mild steel cylindrical case fitted with lifting handles. Trunnions on each side of the casing engage in V-shaped bearings fitted on the inside of the main framework. When the bath is to be used for different heating operations, involving a change of tube, the appropriate tube can be mounted in position quickly and simply.

Two closely spaced electrodes are immersed in salt at the back of the pot. These electrodes extend over the back of the bath and are fitted with copper contact clamps to engage with two fixed U-shaped spring contacts mounted in the cubicle. An advantage of this design is that the pot can be changed without the necessity for disconnecting cables. Furthermore, the connection is automatically broken at the spring contacts whenever the bath is tilted (as shown in Fig. 24), for emptying, cleaning, renewing or changing the salt.

The single-phase transformer is mounted in the base of the cubicle at the rear of the equipment. All the controls are conveniently grouped together on a panel, which forms the upper part of the cubicle housing the electrical equipment. A small hand wheel on the lower portion of the control panel operates a tapping switch for regulating

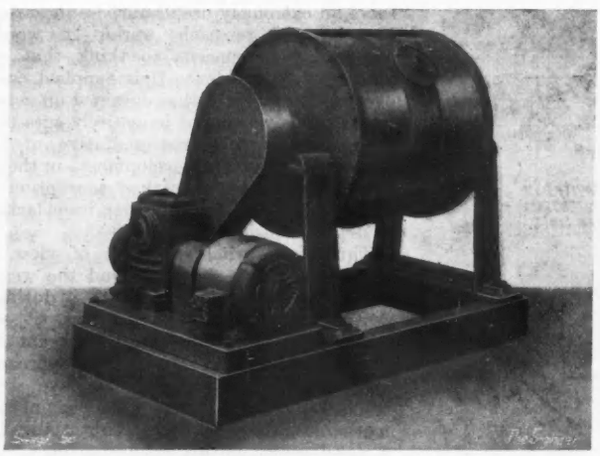


FIG. 22—"LINATEX" BALL MILL—WILKINSON

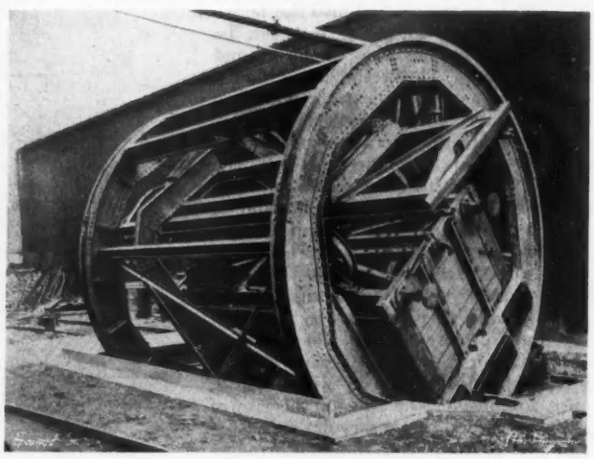


FIG. 23—WAGON TIPPLER—STRACHAN

the transformer voltage. Protection is afforded by a double-pole contactor and main fuses, and a main isolating switch is fitted on the left of the tapping switch. On the right of the tapping switch is the control

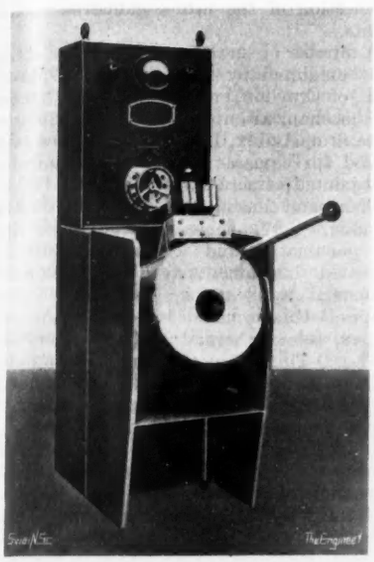


FIG. 24—MIDGET ELECTRODE SALT BATH —ELECTRIC FURNACE CO.

knob of a Sunvic energy regulator. Near the top of the panel is a flush-mounted ammeter between the red and green pilot lamps.

Suitable temperature indicating gear or automatic control gear can be fitted as an extra item by the maker. Another non-standard fitting which can be incorporated if desired is a swinging cowl for the removal of salt fumes.

SMALL TOOLS

Portable electric drills, screwdrivers, grinders, hammers and other tools of all types and sizes were to be seen in the comprehensive display on the stand of S. Wolf and Co., Ltd., of Hanger Lane, London, W.5. The exhibit arranged by H. W. Ward and Co., Ltd., Selly Oak, Birmingham, included tools and toolholders suitable for all makes of capstan and turret lathes, and the firm also showed a number of automatic chucks, air-chucking devices, special fixtures and attachments for turret lathes.

The hardness and working properties of "Stellite" at high temperatures was a feature of the demonstrations given on the stand of Deloro Stellite, Ltd., of Shirley, Birmingham.

F. Gilman (B.S.T.), Ltd., of Smethwick, showed a number of light flexible shaft machines adapted for wire brushing, grinding, polishing, rotary filing and milling, and heavier machines for boiler scaling, rust and paint removing, &c.

All kinds of portable electric and pneumatic tools were to be seen upon the stand of Desoutter Brothers, Ltd., of Hendon, London, N.W.9. This firm also arranged an interesting demonstration of high-speed screwdriving and nut running on small assemblies. Two methods of screwdriving were shown—one incorporating a bushed jig plate where the operator applied the power screwdriver to the work and the other where the work was brought to the tool by means of compressed air cylinders.

E. H. JONES (MACHINE TOOLS), LTD.

A particularly wide and interesting range of measuring and inspecting equipment was shown upon the stand of E. H. Jones (Machine Tools), Ltd., Edgware Road, The Hyde, London, N.W.9. Many of the instruments have been described in these columns from time to time, so we have selected a recently

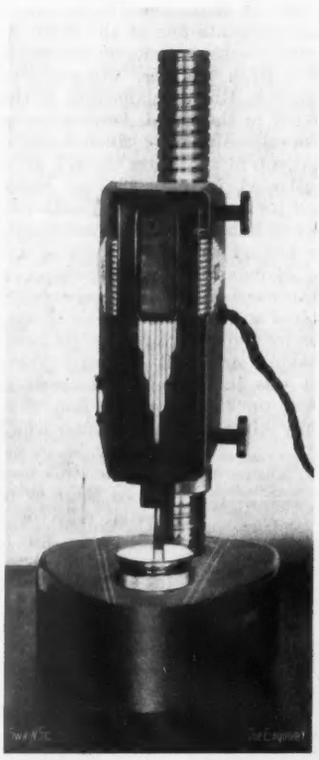


FIG. 25—OPTICAL COMPARATOR—JONES

introduced "Sigma" optical comparator and a horizontal measuring machine for brief reference.

The optical comparator, illustrated in Fig. 25, is designed for inspection of reference blocks and similar parts by comparison of size within, it is claimed, one millionth of an inch. The instrument comprises a heavy base with a pillar on which the measuring head can be adjusted to admit pieces up to 6in high. An electric supply to the head is used for illumination purposes only. Within the head the magnifying mechanism uses a system of multiple reflections from two tilting mirrors, which causes the emitted beam to turn through an angle twenty-six times as great as the angle through which the mirror turns when actuated by the contact point. A magnification of 15,000 to one is given and one division on the scale represents five-millionths of an inch, the range of the scale being $\pm 0{\cdot}0005$in. The operating pressure of the instrument is 8 oz and is kept constant within $\pm 0{\cdot}5$ oz by a special device throughout the whole range of the scale.

The horizontal measuring machine is equally suitable for disc or ring gauge checking or length measurement against reference block standards or standard length bars. It consists essentially of a headstock and a tailstock adjustably mounted on the ways of a bed. Machines are available with capacities to suit various lengths of work and are supplied with a suitable set of end standards which can be built up to any length in 1in increments to the full capacity of the machine. The tailstock of the machine incorporates a precision micrometer screw having a travel of 1in. The drum of this micrometer is calibrated directly to 0·0001in, and this scale is further subdivided by direct reading to 0·00002in by means of a scale on an instrument fitted on the headstock of the machine. When the machine is used for length measurement the end bars and the part being measured are supported on vee blocks mounted on adjustable cradles.

STANHAY (ASHFORD), LTD.

A small mobile crane, illustrated in Fig. 26, was exhibited by Stanhay (Ashford), Ltd., of Ashford, Kent. It has a chassis of the three-wheeled type, having a single forward wheel for steering purposes. Power is transmitted to a conventional rear axle through a three-speed gearbox, from a Ford 10 h.p. engine situated behind the driver's cabin. The jib is an extension of a rigid closed frame, which is pivoted to supporting members over the cabin, and it is actuated by the piston-rod projecting from the top of a compressed air cylinder situated at the rear of the main chassis. Air is supplied to the cylinder from two air receivers fed by a small air compressor driven from the engine crankshaft.

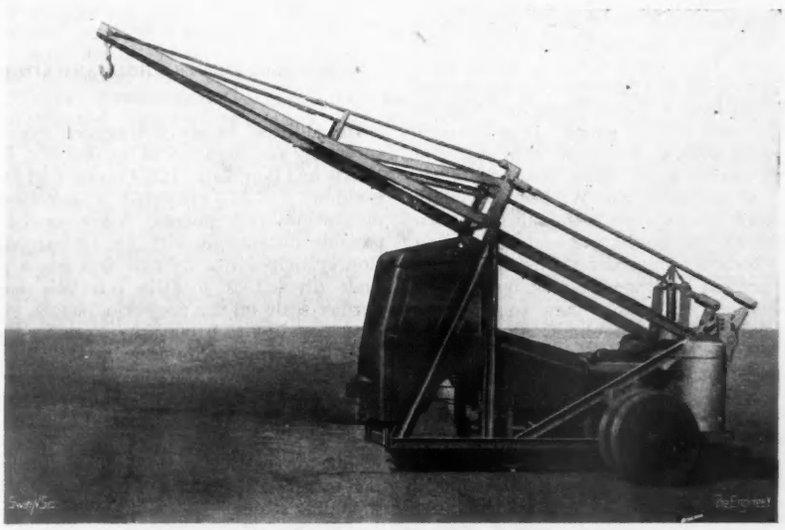


FIG. 26—MOBILE CRANE—STANHAY

The hook at the end of the jib is fixed and the jib serves to raise the load to the

required height, after which all manœuvring is effected by movement of the vehicle itself. Driving and manœuvring of the crane is by means of the normal road vehicle arrangement of a foot brake, clutch and accelerator. Jib raising and lowering is controlled by movement of a single small lever mounted in a convenient position at the driver's right hand.

These cranes are made in two standard sizes for handling loads of 1 and 2 tons, with jibs 12ft 6in and 8ft long respectively, with maximum outreaches of 9ft and 4ft 6in. The maximum and minimum jib heights of the lighter crane are 15ft 8in and 4ft, and of the 2-ton crane 12ft 4in and 4ft 11in. Each model has a maximum road speed of 9·7 m.p.h., an unladen weight of 3 tons 15 cwt and a turning radius of 9ft 1in. It is stated that the design can be modified in various ways to suit the cranes to special loading and working conditions.

W. G. Allen and Sons (Tipton), Ltd.

Amongst the various mine and other types of cars and tubs on the stand occupied by W. G. Allen and Sons (Tipton), Ltd., Princes End, Tipton, there was to be seen this firm's latest design of electrically welded mine car known as the "Vanguard."

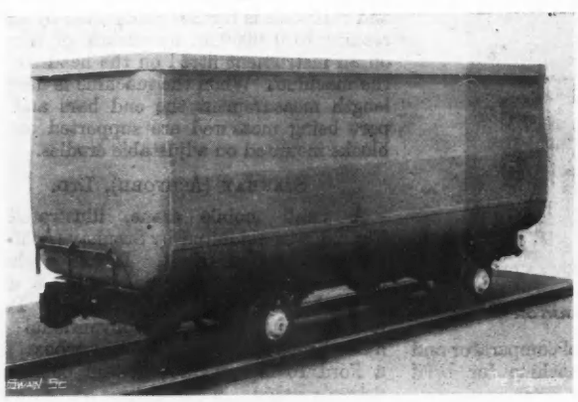


Fig. 27—Welded Mine Car—Allen

The car exhibited is of 4 tons' capacity and, as may be seen from the photograph we reproduce in Fig. 27, has particularly clean lines without any projecting parts. It has an overall width of 4ft and 12ft 6in coupling centres, the height from rail level being 5ft. The car is built for a 3ft rail gauge. It is mounted on sprung axles and is fitted with cast steel wheels having taper roller bearings in the hubs. If required, the Willison automatic couplers of the cars can be supplied in a form suitable for car tipping without uncoupling.

The body is electrically welded throughout with pressed steel end plates bevelled on the corners to enable cars to negotiate curved track without fouling. All beading is on the outside of the body, but does not project beyond the widest portion.

British Thomson-Houston Company, Ltd.

Many far-reaching improvements in lighting methods have been made in the eight years that have elapsed since the last British Industries Fair was held, and some interesting examples of recent progress were to be seen on the stand of the British Thomson-Houston Company, Ltd., Rugby.

Some of the more important advances in lighting practice have been associated with the development of the fluorescent lamp. Since the Mazda 80W, 5ft fluorescent was introduced in March, 1940, continued research has led to substantial improvements. Whilst the cost of the lamp has decreased by 34 per cent, the life of the lamp and its average efficiency throughout its life have both increased by some 50 per cent. More recently the Mazda 40W, 4ft fluorescent lamp has made its appearance.

The use of fluorescent lamps for street lighting represents one of the more spectacular major achievements in street-lighting technique since the war. An experimental installation in Rugby, claimed to be the first of its kind in the world, became the prototype for the Mazdalux fluorescent street-lighting lantern shown on the B.T.H. stand. As illustrated in Fig. 28, the lantern is designed for use with three Mazda 80W 5ft fluorescent lamps. All the auxiliary lamp gear is housed within the lantern, and the method of mounting and suspension can be varied to meet individual requirements.

The fuel and other economies that can be effected by using infra-red lamps for drying and baking are well known. Particular interest was therefore focused on an exhibit that was on show for the first time—an internally silvered infra-red lamp which will shortly be in production in this country. Since there is no external reflector to be kept clean, maintenance time is considerably reduced. The new lamp is more efficient than its predecessors, and the internal reflector gives better concentrations of infra-red rays.

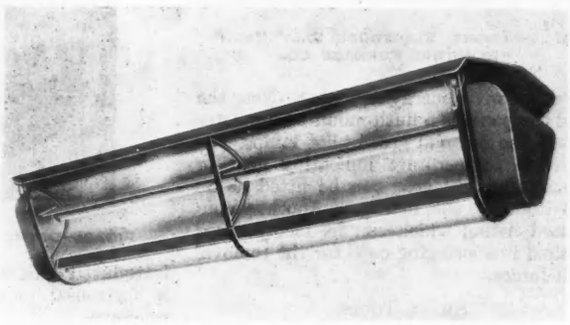


Fig. 28—Fluorescent Lighting Street Lantern—B.T.H.

Surveying, Metrological and Other Instruments

In addition to its well-known range of surveying and geophysical instruments, E. R. Watts and Son, Ltd., 123, Camberwell Road, London, S.E.25, exhibited a selection of metrological instruments. A new small direct gauging instrument with an optical projection system shown by this firm has a glass scale divided at 0·001in intervals and a vernier scale on the projection screen giving direct reading to 0·0001in.

A large fully automatic quartz spectrograph, together with a spectrum projector and a non-recording microphotometer outfit, exhibited by Adam Hilger, Ltd., 98, St. Pancras Way, London, N.W.1, formed a complete equipment for the quantitative and qualitative analysis of metals and alloys, including steels.

Amongst the precision measuring and checking instruments to be seen upon the stand of Taylor, Taylor and Hobson, Ltd., Leicester, was the firm's "Autocollimator." This instrument is designed for problems involving the measurement of errors in plane surfaces and in the relationship of one surface to another. It measures the deviation of a beam of light reflected from a mirror located on the surface with a sensitivity of one-fifth of a second of arc.

A comprehensive range of theodolites, levels and microscopes of all types was shown on the stands of Cooke, Troughton and Simms, Ltd., of York, together with a selection of the firm's industrial instruments.

A number of surveying levels of the tilting type exhibited by Hall Brothers (Optical), Ltd., of Croydon, embody the latest optical and mechanical improvements, and an associate firm, Agilux, Ltd., showed a new table tripod for cameras which has a universal ball-jointed camera attachment.

Short and Mason, Ltd., of Walthamstow, London, E.17, showed a complete line of pneumatic and electro-pneumatically operated instruments suitable for many industrial applications, comprising "Fulscopes," time schedule controllers, process timers, safety thermal limit recorders and "Flex-O-Timer" positioners. A complete panel of aircraft instruments in the meteorological section of the firm's exhibits included the altimeter, rate of climb indicator, revolution indicator, undercarriage indicator, boost gauge, oxygen regulator and the radiator thermometer.

A full range of binoculars and monoculars was shown on the stand of Barr and Stroud, Ltd., of Anniesland, Glasgow.

A film projector made by the Pullin Optical Company, Ltd., of High Wycombe, Bucks, designed to take 35mm film strips or 2in by 2in transparencies has a masking system provided to permit the projection of either double frame or standard cine films.

An exhibit of particular interest on the stand of Optical Measuring Tools, Ltd., of Slough, was the "Newall" film studio camera, which has been designed specifically for the J. Arthur Rank Organisation, but which will eventually become available to film studios throughout the world. This firm also exhibited its well-known "Omtimeters," tool-makers' microscopes, inclinable tables and other precision optical measuring instruments.

Other Exhibitors

In addition to a representative range of testing and weighing machines, W. and T. Avery, of Birmingham, had on its stand a model working combination of machines for feeding, sieving and weighing powdered materials by high-frequency vibrating equipment with pneumatic control gear.

Some of the larger productions of Vickers Armstrongs, Ltd., were represented by models of H.M.S. "King George V," the liner "Strathmore," a cement plant, a condensing plant and a colliery winder. A representative selection of actual products included a Vickers-Gill pump.

(*To be continued*)

The Iron and Steel Institute

No. I

A THREE-DAYS' meeting of the Iron and Steel Institute was held in London on May 14th, 15th and 16th under the Presidency of Dr. C. H. Desch, F.R.S., the first day being devoted to a discussion on the hardenability of steel. This was organised by the Technical Advisory Committee of the Special and Alloy Steels Committee (Ministry of Supply) and the Iron and Steel Institute.

The Symposium was introduced on Wednesday morning, May 14th, by Mr. D. A. Oliver, Chairman of the Hardenability Sub-Committee of the Technical Advisory Committee of the Special and Alloy Steels Committee (Ministry of Supply).

Mr. C. R. Wheeler (Guest, Keen and Baldwins, Ltd.), who was chairman of the Commission that went to America during the war, said that in order fully to appreciate the importance of this Symposium it was necessary to know something of the background at the time. There was a severe shortage of certain alloying materials, both in America and here, partly on account of shipping difficulties but also not a little due to actual shortage of sources of supplies. It was decided to send a party to America and discuss exactly what we were doing in the whole range of war production as applied to alloy steel. A remarkable success was achieved in the spirit in which the discussions were held. Naturally, there was controversy on this subject of hardenability, but notwithstanding the different points of view a joint report was produced. This discussion of these problems with America was another link in the Anglo-American co-operation which was, perhaps, one of the most, if not the most, decisive factors in the defeat of the Axis.

Dr. W. Steven then introduced a discussion on "Reproducibility of End-Quench Hardenability Curves," based on the following conclusions of the Symposium.

Reproducibility of End-Quench Hardenability Curves

The end-quench test is capable of yielding satisfactorily reproducible results provided that the material tested is homogeneous.

End-quench curves determined in a number of different laboratories on samples of three different steels cut from commercially homogeneous bars, approximately 12ft long by 1¼in in diameter, gave end-quench curves agreeing within close limits. The maximum variation noted on these steels was ±0·07in in terms of distance from the quenched end of the test specimen to the steep part of the curve.

The results of an end-quench test are not appreciably affected by small changes in the testing conditions.

The temperature of the quenching water, the free height of the jet, the diameter of the jet orifice, the distance from the orifice to the under surface of the test specimen, the length of the test specimen and the duration of end-quenching, can be varied within fairly wide limits without significantly affecting the end-quench curve.

End-quench curves determined on different samples of bar, forged or rolled from the same ingot to approximately the diameter of an end-quench test specimen, generally show only small differences.

Samples from bars of 1¼in diameter derived from different parts of sixteen ingots representing five B.S. En steels have been tested. The greatest variation of hardenability noted in the product of a single ingot, in terms of the distance from the quenched end to the steepest part of the curve, was an increase of from 0·95 to 1·4in from the bottom to the top of a 12-cwt ingot of B.S. En 22. The hardenability variation observed in the majority of the other ingots examined was considerably less.

End-quench curves determined on different samples of bar, forged or rolled from different ingots of the same cast to approximately the diameter of an end-quench test specimen generally show only small differences.

End-quench curves determined on samples of 1¼in diameter bars rolled from different ingots from each of a series of casts showed hardenability variations of a similar order to those noted within the product of a single ingot.

A marked variation of hardenability may exist across the section of a bar.

The remarks made in paragraphs (3) and (4) concern tests of which the results would not be influenced by the existence of transverse variations of hardenability.

End-quench tests on specimens prepared side by side from steel bars exceeding considerably the diameter of the test specimens indicated significant variations in hardenability across the section of the bars examined. Generally, though not invariably, the hardenability at the centre of a bar is lower than that at the surface.

The transverse variations may be accompanied by longitudinal variations when the test flat represents material within the section of the bar.

A spectrographic survey across one billet which showed substantial variation of hardenability from outside to centre demonstrated that this variation is not completely explained by chemical heterogeneity. The examination of other billets with variable hardenability has shown that the variations are not accounted for by local differences in McQuaid-Ehn grain size.

The end-quench hardenability of a steel may be slightly affected by variation of the structure before quenching.

Examination of the hardenability of a hypereutectoid chromium-molybdenum steel suggests that the amount and condition of the carbide remaining out of solution at the moment of quenching has a significant effect on end-quench hardenability.

Mr. T. M. Service (William Beardmore and Company, Ltd.) asked whether it was the right thing to do to base the whole treatment of steel on the question of hardenability. Mr. Oliver had stated that large differences of hardenability might arise within a single cast. Therefore, it seemed necessary to conclude that no single end-quenching hardenability curve could be regarded as sufficiently representative of hardenability of any part of the ingot or even, in some cases, of a single bar of steel. If that were the case, was hardenability the right method of going about the job? There were one or two points that had never been investigated. In the first place, he suggested that the Committee should investigate the quality of the steel they had been using. A second point was the temperature for rolling. Were these bars all rolled at the same temperature or were there differences in temperatures of rolling? Anyone with experience of steel-making knew that heating for rolling was part of the heat treatment and had some influence on the ultimate quality of the steel. Therefore probably some of the differences indicated in the Symposium with regard to hardenability would not occur with uniform steel and uniform heating for rolling. Again, no time was given for the mass effect. All that was said was the bars were heated for a certain time at a certain temperature and then hardened, but the actual time was not stated. What about the change that took place inside the mass? What was stated in the Symposium might be all right for a 1in bar but the position was quite different with 4in, 8in, 24in, or even larger bars, and it was necessary to know what happened inside them. Further, no indication was given of the time the material should be kept at the hardening temperature.

Mr. G. Meikle (R.A.E., Farnborough) suggested that quite a number of variations for which no explanation was given in the Symposium might be connected in some way with retained austenite, but that problem had not been investigated by the committee.

Dr. J. H. Whiteley (Consett Iron Company, Ltd.) said that in dealing with the hardenability curves, he had been surprised that very little mention had been made of the S curve, especially with regard to the hardenability of ordinary plain, carbon steels. He urged that more examination should be given to S curves in relation to the various Jominy tests mentioned, but it was a mathematical work and could well be undertaken by Mr. T. F. Russell. He had a feeling that the S curves would throw a great deal of light on the shape of the Jominy curves.

Mr. H. H. Burton (English Steel Corporation, Ltd.), remarking that Dr. Steven had referred several times to the surface materials showing a greater hardenability than the inside, said the term "surface materials" was hardly correct. It was more probably the columnar material and the specimens should be micro-etched longitudinally in order to show whether or not that was the fact.

Dr. F. W. Jones (Brown-Firth Research Laboratories) suggested that the only influence that retained austenite was likely to have on the Jominy hardenability curve was in the hardness at the quenched end of the bar. Further along the Jominy bar the softening was due to the transformation from austenite to ferrite and carbide at a fairly high temperature, and that was what largely determined the hardness of the material. Therefore, he did not think the retained austenite was likely to have very much influence on the hardenability of the steels.

Dr. W. Wrazej (Royal School of Mines) said it was a great pity that the chemical analyses of the steels investigated in these researches were not complete with respect to the determination of gases in the steels. A reasonable prediction of the behaviour of steel during heat treatment should really be based on the chemical analysis, when complete analyses could easily be obtained, and on the nature of the atomic arrangement in quenched steels.

Mr. R. J. Brown (Nuffield Central Research Laboratories) said the standard American Jominy test bar was produced from a bar which was either rolled or forged, but in the present case the diameter of the bar was mentioned without any reference to the material from which it was produced. Therefore a very big variable had been introduced into this work. Another point was that whereas the Jominy test was evolved from the user's angle, the papers now under discussion were presented from the manufacturer's angle. As a user, he felt that a greater control of the property of hardenability—however it might be determined—was essential. In the United States, the tendency in the past had been to limit the chemical composition much more closely than in the British specification but the hardenability test indicated that even closer limits of composition were not sufficient to iron out the difficulties experienced in the bulk heat treatment of steel components, i.e., bulk heat treatment as we did not know it in this country. In addition, some form of hardenability test—either the Jominy or any other—was essential, and the practical heat treater was more interested in the response of the surface layers of steel than of the core. But the

latter must be taken into account, particularly in the case of components of varying sections machined from a fairly large piece of steel. However, the surface layers of a component were, generally speaking, the stressed layers and it was in these that considerable interest should also be taken.

Dr. Steven, replying to the discussion, said that the steels used were normal examples and were known adequately to meet all normal specifications. Yet they had been shown to possess wide internal variations of hardenability. As to some of the variations of hardenability being due perhaps to variations of rolling temperature, he said the bulk of the end-quench curves were from samples which had been normalised before end-quenching and that would partly eliminate the effect of rolling. All the billets referred to in Section VI*b* were rolled at the same time and at the same heat, yet wide variations of hardenability persisted. There was no reason to believe that the rolling temperature had any significant effect on this hardening variation. As to the time allowed for mass effect, one hour per inch of diameter was allowed at soaking temperature, and he thought that would be agreed as more than adequate.

Mr. J. Glen then introduced a discussion on "The Influence of Chemical Composition on Hardenability," based on the following conclusions of the Symposium.

HARDENABILITY AND CHEMICAL COMPOSITION

A wide variation in end-quench hardenability may exist between different casts of steel produced to the same specification.

End-quench curves determined on samples from bars rolled to approximately the diameter of an end-quench test specimen, from a number of casts within the chemical limits of each of a variety of specifications, showed wide variations in hardenability. These are largely explained by variations in chemical composition within the ranges permitted by the specifications; but, as mentioned in paragraph (5), variations unaccounted for in this way are possible.

The hardenability of a steel cannot always be calculated with satisfactory accuracy from a knowledge of the chemical composition and grain size.

The variation of hardenability with chemical composition has been shown to be complex. No wholly satisfactory method has been derived for calculating hardenability from a knowledge of chemical composition and grain size, although the method introduced by Grossmann gives a first approximation for certain types of steel.

Dr. N. P. Allen (National Physical Laboratory) said that many of the difficulties in assessing the effect of an alloying element on hardenability, arose from the fact that there was no such property of steel as hardenability at all! He thought that Grossmann had something to answer for in setting out on what, in his view, was a false attack. There was sufficient information available at the time for Grossmann to know that his multiplying factor idea was essentially a wrong idea, and would not work. What had to be done was to put the problem into its various parts and study the effect of the alloying element and each of the reactions, which were important in this connection. But that would take a long time. Meanwhile, Mr. Glen's paper would be found to be a mine of information and a guide as to what the general effect might be expected to be.

Mr. E. H. Bucknall (Mond Nickel Company, Ltd.) said that Mr. Glen had shown that this problem was more complex than Grossmann had indicated, although Mr. Glen seemed to favour some of Grossmann's ideas to a greater extent than others would feel was justified. As regards Mr. Glen's observations on the effect of additions of boron and aluminium on hardenability of alloy steels, he had shown, as had been found by others, large effects through such additions. He felt, however, that the question should be raised as to what steps were taken to ensure that the results were accurately interpreted having regard to the difference between American and British experience in this respect. It was known for certain that boron exercised a considerable effect on the mechanism of transformation in steels and there were a considerable number of elements which might either be introduced intentionally in steel making, or creep in incidentally to various extents, and have a beneficial effect on hardenability, via their effect on the transformation characteristics.

The meeting then adjourned until the afternoon.

The discussions in the Symposium were continued on Wednesday afternoon, May 14th.

Mr. T. F. Russell introduced a discussion on "The Prediction of Hardness and Transformation Ranges from End-Quench Hardenability Curves," based on the following conclusions of the Symposium.

PREDICTION OF THE HARDNESS OF QUENCHED AND QUENCHED AND TEMPERED BARS FROM HARDENABILITY CURVES

The hardness traverse curves of an oil-quenched bar cannot be derived consistently with adequate accuracy from a single end-quench curve.

In view of the transverse variations of hardenability noted, it is clear that no single end-quench curve can be regarded as representative of the hardenability of a given cast of steel. The effect of the variation of hardenability throughout the material from a single cast is of such magnitude that hardness traverse curves derived from a single end-quench curve are scarcely better than approximations.

Hardness traverse curves can, however, be derived with satisfactory accuracy if the hardenability variation is taken into account by using a series of end-quench curves determined on specimens machined from suitable positions across the bar section. The theory underlying the procedure adopted in deriving hardness traverse curves from end-quench curves can therefore be regarded as substantially correct.

The hardness of a quenched and tempered bar may be derived with satisfactory accuracy from an end-quenched and tempered test specimen.

The effects of the variation of hardenability within a cast appear to be largely smoothed out by tempering. The hardness of a quenched bar subsequently tempered to less than about 350 Brinell hardness can be derived with adequate accuracy from the curve determined on an end-quenched and similarly tempered hardenability test specimen.

Mr. N. P. Allen (National Physical Laboratory) thought that entire confidence could be had in the calculations that had been carried out but at the same time it was necessary to examine the assumptions behind these calculations. In the first place, it was assumed that if in two pieces of the same kind of steel the cooling rates were the same at two points, the hardness and general properties would be the same. Nobody would quarrel with that but there were also other assumptions which were not necessarily so acceptable and made the problem a very complicated one. For example, it was very noticeable throughout the Symposium that the various workers had had the greatest difficulty in assigning a quenching intensity figure to any particular quenched alloy and, looking through the Tables, he had the rather definite suspicion that the quenching intensity of an alloy was not constant but was a function of the hardening capacity of the steel and also of the size of the bar. In this connection, an account of some work done by Pumphrey and Jones was shortly to be published. In this they had measured the quenching intensities directly and found with certain bars that the effective quenching intensity varied according to the temperature of the steel and also according to the size of the bar. That confirmed the general impression left from the work described in this Symposium that there was difficulty in fixing quenching intensities and that there was a real doubt whether the quenching intensity was constant. Therefore the truth of that matter must be found out, because the position at present was uncertain.

As regards the validity of the half-temperature time as a criterion of cooling rate, the paper by Pumphrey and Jones to which he had referred showed that in the case of the majority of steels of the type investigated, transformation took place at temperatures before the half-temperature point. Therefore any correlation should be based on a rate of cooling at some lower temperature—more in the region of 500 deg. to 300 deg. Cent. for the average steel than 900 deg. to 700 deg. Cent. It was important to point out that the evolution of latent heat did alter the rate of cooling of the steel in quite a substantial way. In view of these various objections, it was surprising that the correlation shown in the Symposium was as good as it was.

Whilst he did not wish to minimise the importance of the Jominy test, there was a case against over-elaboration of the mathematical side of the problem. The virtue of the Jominy test was that a comparison could be made between it and the Brinell hardness test. There was a correlation between Brinell hardness and tensile strength but it was not exact. It depended on several factors and nobody worried much. It could be found by experience how much the correlation could be trusted and, on the whole, he felt they were on sounder ground and would get along much faster by proceeding on these lines.

Mr. E. H. Bucknall (Mond Nickel Company, Ltd.) said that it was reassuring that the sub-committee were able to conclude that provided due notice was taken of the variations of hardenability across the section, a good correlation could be obtained between end-quench results and cross-sectional hardness results. That conclusion, as a matter of fact, was at variance with a recent paper by Murray at the Battelle Memorial Institute, who asserted a lack of correlation even where the Jominy test represented points across the section of the bar.

Mr. Russell replied shortly and promised a full reply in writing.

The final discussion in the Symposium was on "The Influence of Hardenability on Mechanical Properties," based on the following conclusion of the Symposium. It was introduced by Mr. W. E. Bardgett.

HARDENABILITY AND MECHANICAL PROPERTIES

The combination of mechanical properties obtained from steel that has been quenched and subsequently tempered in the range 500 deg. to 650 deg. Cent. (932 deg. to 1202 deg. Fah.) depends on the hardness developed by quenching, but there are serious difficulties in the way of interpreting end-quench curves in terms of the ability of steels to attain a required combination of mechanical properties.

The Izod impact value and yield ratio of steel quenched and subsequently tempered in the range 500 deg. to 650 deg. Cent. (932 deg. to 1202 deg. Fah.) to give the same maximum stress value tend to decrease as the hardness of the steel in the quenched condition decreases. The elongation and reduction-of-area values are not significantly affected.

The combination of mechanical properties usually demanded may often be obtained from quenched and tempered constructional steels which have been only partially hardened by quenching, but the minimum value of the as-quenched hardness required to develop the combination can be determined only from direct tests. Thus no characteristic point on the end-quench curves can be identified as indicating the minimum hardness which will develop the required mechanical properties after tempering.

Mr. H. H. Bull (Brown, Bayley's Steel-

works, Ltd.) said it was a long time since the committee had been formed and it had achieved a great deal, but in this particular section he did not think they had really got down to the practical nature of the work they set out to do, *viz.*, to see what use the Jominy hardness test was in assessing the mechanical properties of various casts of steel, no matter what the alloy content was. To be of any value in a steelworks, the Jominy test must afford a quick and ready means of assessing the mechanical properties of a cast of steel, but the work in this section showed that the Jominy test failed not so much as a hardenability test but that it failed to measure some of the mechanical properties, and particularly toughness. Therefore, this work left us in the same position as we were previously and the Jominy test did not help. Perhaps that was because in this country we laid a great stress on the need for a tough steel. It was suggested in the Symposium that hardenability could be exchanged for toughness, but he was not sure that that was a right conclusion, and he had a feeling that there was a certain shyness in making that suggestion in the Symposium.

The outstanding thing in the discussion of the conclusions in this Symposium was the reference, many times, to what were called inherent differences in properties, which still needed to be explained. It seemed to him that whilst the committee had reached the definite conclusion that the Jominy test could not be applied to alloy steels in this country to indicate the likely mechanical properties in the way they were put into our specifications, the matter could not be left there. It was for that reason he welcomed the note by Mr. Oliver at the end of the Symposium in which he pointed out that further work was to be done. There was no doubt that the steel making industry would welcome any ready means of assessing the properties of steel, and assessing them quickly. Therefore the work of the committee in providing a substitute for the Jominy test would be most valuable if such a test could be designed and applied in much the same way that a chemist applied his knowledge, whilst the steel was still in the furnace. That might sound far-fetched, but he did not think it impossible.

Mr. F. E. Stokeld (Deritend Stampings Company, Ltd.) said that in the drop forging industry they dealt with a very large variety of heat treatable steels, all of which in the form of forgings, must give the specified mechanical properties before delivery. With some steels difficulties were few and far between but with others they were much greater. His experience pointed to two common steels as being the most serious offenders, and in both cases the difficulties were apparently due to lack of hardenability. This phenomenon was the more troublesome to drop forgers, as they must endeavour to avoid the use of water quenching, which was a dangerous procedure owing to the cracking propensities of forgings having uneven sections. Because of the necessity for using oil-quenching whenever possible, they could not afford to make forgings from steels possessing abnormally low hardenability characteristics. There was a real need for a quick and accurate method of obtaining the required information before the steel was taken into use for processing prior to final heat treating. In the absence of such information, difficulties arose which caused loss of output if not loss of the product itself. It was part of the duties of the works metallurgist to prevent such avoidable losses. Any improvement in his methods and practices or any new tools that were available to him for the assessment of material quality would therefore be most welcome. It was perhaps disappointing that the conclusions of the sub-committee did not indicate that the end-quench test itself was sufficient for such a purpose. He certainly supported the warning that caution was needed when the end-quench test was considered as a possible specification requirement. He felt that the best test to date in discovering whether a particular batch of steel was capable of acquiring the specified mechanical properties, or not was to follow the procedure laid down in the appropriate British standard specification for aircraft steels.

Mr. E. H. Bucknall (Mond Nickel Company, Ltd.) said Mr. Stokeld had been emphasising the virtues of a " try it and see " policy as regards the use of steels, but there was one point made abundantly clear from the work described in the Symposium of which nothing had been said so far and to which the attention of Mr. Stokeld should be drawn. It was that if Mr. Stokeld set out on his " try it and see " policy of hardening and tempering a wide variety of steels to decide their suitability for use in particular sections, and relied on the Jominy test as no more than a preliminary selection test—to eliminate from consideration those materials which were obviously out of court—he would greatly reduce his task. As a warning to anyone wanting to take the interpretation of the Jominy test as regards mechanical properties any farther, reference should be made to Section IVc of the Symposium where, in a paper to which little attention had been given in the discussion, Pumphrey and Jones described their study of the transformation ranges of hypereutectoid steels by means of interrupted Jominy end quenches. It was impossible to exaggerate the value of such work in the field between the Jominy test and transformation measurements as regards finding out the fundamentals of the mechanical properties of alloy steels. The Jominy curve, as normally determined, told almost nothing from that point of view.

It could be said quite definitely that little support could be given to the contention which used to be advanced in America that so long as the same microstructure was achieved in quenching, the mechanical properties of steels were the same. That assertion was fortunately being watered down to-day, and it would be a very good thing when it disappeared altogether.

Mr. A. Preece (Leeds University) asked whether the sub-committee had considered the diffusion rates of carbon and other elements in the steels they were studying. Fundamentally, hardenability was a problem in diffusion and any information obtainable from research of that type might be of some use in the solution of the main problem.

Mr. Bardgett, replying to the discussion, dealt with a few points and promised a full reply in writing.

The President, expressing the thanks of the meeting to the authors of the various Sections of the Symposium, and those who had taken part in the discussion said the work dealt with had to be done for urgent national reasons, and therefore it was not surprising that attention had been given mainly to the practical side. Now that the work was to go on, it was to be hoped that consideration would be given to the fundamental reasons for the behaviour of the different steels. It was, on the whole, perhaps rather disappointing to look through a report of this kind and find how very difficult it had been to obtain any real correlation between the hardenability and either the chemical composition or the microstructure. He hoped it would be possible to carry the work very much farther and to make a careful study of the changes which went on, making use, if possible, of the electron microscope, in view of the fact that a great deal of the difference in the properties was concerned with the properties of the grain boundaries and not simply of the mass of the grains.

This concluded the Symposium on the Hardenability of Steel.

(To be continued)

Heavy Shunting Locomotives for Port of Calcutta

SIX 0–6–2 tank locomotives, incorporating some interesting features were built by the Hunslet Engine Company, Ltd., of Leeds, and were recently delivered for heavy shunting work at the port of Calcutta. Their unusual wheel arrangement for a docks locomotive was necessitated by the ample water capacity desired on a nominal axle loading and in view of the fact that very heavy trailing loads would have to be handled round the usual dock curves. The preliminary design and specification was drawn up by Messrs. Rendel, Palmer and Tritton, the consulting engineers, who afterwards worked in close collaboration with the builders on the detailed design of the locomotives.

Stipulations were that a load of 1280 tons trailing, made up of forty four-wheeled wagons of 15ft wheel base, should be hauled round a curve of 300ft radius, on which seventeen of the wagons would be travelling at one time. The locomotive alone had to be capable of negotiating a 250ft radius curve without gauge widening, and sufficient fuel and water had to be carried for twelve hours of continuous working.

In certain respects the specification was stringent. Originally an axle load not exceeding 16 tons was contemplated, but to get adequate tractive power to cope with increasing loads at the port a maximum of 17 tons was sanctioned. The makers were able to keep below this figure and yet show a good division of adhesion weight over the three coupled axles in the full working order condition. With tanks and bunker empty the distribution is not so favourable, but under usual working conditions the coupled wheel loading is still satisfactory.

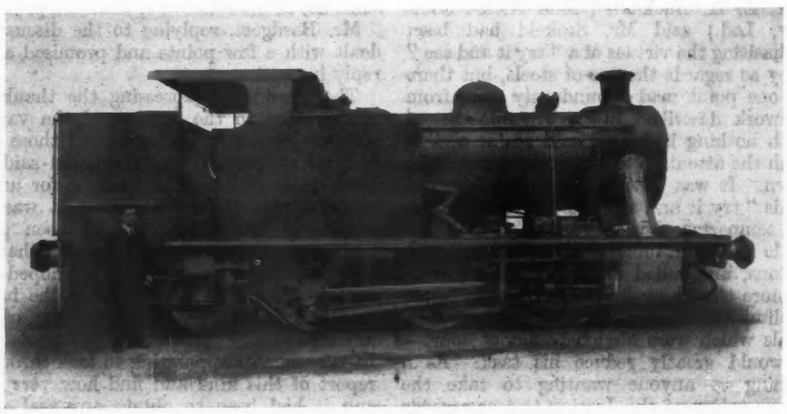
In order to comply with port working requirements the locomotives have an ample rail clearance of 5½in with new tyres, despite the adoption of coupled wheels of only 3ft 10in diameter. For simplicity of construction and ease in general maintenance the engines have been designed to work on saturated steam at the comparatively high pressure of 210 lb. The firebox and boiler proportions have been adjusted in order to use poor-class Indian coal with a calorific value averaging 12,000 B.Th.U.

The design prepared to meet the requirements and fulfil the usual " Standard Specification " for Indian locomotives is the engine shown in the accompanying illustration. The

leading dimensions of the engine are as follows :

Cylinders (two)	16in by 24in
Wheels, coupled	3ft 10in diameter
Wheels, trailing	2ft 6in diameter
Wheel base, rigid	11ft
Wheel base, total	16ft 6in
Evaporative heating surface :	
Boiler tubes	940 square feet
Firebox	90 square feet
Total	1030 square feet
Firegrate area	18·1 square feet
Boiler pressure	210 lb per square inch
Adhesion weight	49½ tons
Weight in working order ...	65 tons
Tractive effort at 75 per cent boiler pressure	21,000 lb
Tractive effort at 85 per cent boiler pressure	23,840 lb

Although the boiler pressure is limited to 210 lb per square inch in service, its design calculations were based on 220 lb per square inch. With a tractive effort of 21,000 lb, based on 75 per cent boiler pressure, the factor of adhesion is 5·25, against the adhesion weight of 49·2 tons, and is stated to be above 4·0 under the worst possible conditions. The boiler is not pitched at great height and the smallness of the coupled wheels would have permitted a deep firebox had not the ashpan requirements to suit the poor indigenous coal taken up a good deal of space above the rear coupled axle. The ashpan itself is of the hopper type, with cast steel bottom hopper doors and operating mechanism at the side. The front section of the firebars is of the drop type, worked manually from the cab.



0-6-2 TANK SHUNTING LOCOMOTIVE

One ring, $\frac{9}{16}$in thick, is used for the boiler barrel, which contains 200 steel tubes, 1¾in outside diameter and 10ft 3in long, pitched at 2⅜in centres, giving a bridge of ⅞in (nominal) in the firebox tube plate. Flexible staying is confined to the top two rows and front and back vertical rows of side stays, and the three front rows of roof stays, all of which are of the Flannery type. Boiler fittings include two 3in Ross pop safety valves, a Joco double-beat balanced regulator with a long double-way handle in the cab, and two blow-off cocks. Apart from the copper internal steam main, there are no pipes inside the boiler. The feed arrangements comprise two Gresham and Craven 8mm live steam injectors, a Worthington duplex pump on the left-hand side of the running plate and a treble clack box—but not a top-feed tray series arrangement—on top of the barrel at the front end. Adequate washout facilities have been provided in order to cope with the effects of the hard feed water.

The engines have plate frames, 1½in thick, to which the cross bracing is riveted. The horizontal bracing countering the racking stresses is of substantial design in order to stay the frame adequately for shunting work, and the strong construction at the front end below the smokebox saddle is also noticeable. Standard side buffers and central drawbars both have Spencer Moulton rubber springs. No wedge adjustment is provided in the cast steel hornblocks, which are fitted with case-hardened liners, and the coupled axleboxes are of solid bronze with Ajax container type grease lubricators. The axlebox journals are pitched at 4ft 2in transverse centres, whilst the distance between the frames is 4ft 9in.

Overhung laminated bearing springs, which are fitted throughout the engines, are compensated in two groups down each side, the trailing coupled springs being connected to those of the radial truck. Each spring is made up of thirteen plates, 4½in wide by ½in thick, with the non-adjustable hangers set at a nominal distance of 36in. The trailing radial truck is arranged for a total side play of 5½in—this movement corresponding to a 250ft curve—and has its lateral movements controlled by a helical steel spring. This spring is adjusted to give an initial restraining force of 1·32 tons and a final compression of 2·15 tons.

Of the six coupled wheels, the centre pair are flangeless and their tread of 5⅜in is ½in wider than that of the end pairs. The wheel centre castings are of steel and cast iron thrust faces fitted to the hubs are lubricated by grease nipples. Revolving weights on each wheel are balanced, and of the 33 per cent of the reciprocating weights balanced down each side, 11 per cent is distributed over each coupled wheel. Hammer blow is stated to be negligible even at speeds of about 25 m.p.h. The counterweights in the wheels are formed by plates riveted on each side of the spokes to form a pocket which is filled with a mixture of 95 per cent lead and 5 per cent antimony.

The builders only made on pattern for the two cylinders, each casting being applicable to either side of the engine. The lack of a superheater simplified the arrangement of the live steam pipe, and the exhaust branch from each cylinder has only one large-radius curve in one direction, cylinder and blast pipe centres being on the same line. The blast nozzle, which is 4⅞in diameter, is 12in below the boiler centre line.

The pistons are of box form with two narrow rings. Cylinder and valve lubrication is effected from a Wakefield six-feed mechanical lubricator driven from an arm on the right-hand side reversing link. A point of the design is the long connecting-rod—10ft 2in between centres—which gives the low slide bar thrust desirable for locomotives of this general class. Coupling-rod ends and connecting-rod big ends have fully-floating bronze bushes. A stop is provided on the inner end of the slide bars so that, after the gudgeon pin is disconnected, the crosshead and rod can be moved forwards far enough for the piston rings to be renewed and the cylinders examined from the front.

The 8in diameter inside-admission piston valves are actuated by a Walschaerts gear driven off the rear wheels, an arrangement which provides eccentric and radius rods of adequate length. The piston valve heads are kept tight by five narrow rings. The motion, with 1½in pins, is fitted with renewable cast iron bushes, except for a phosphor-bronze bush between the eccentric rod and the fly crank. Screw reversing gear is arranged on the right-hand side of the engine and needs ten turns from full forward gear to full backward gear. Valve events provide for a maximum travel of approximately 4⅞in in forward and backward gears, corresponding to a cut-off averaging 82 per cent in both directions. Valve lap is 1in and exhaust lap $\frac{3}{16}$in.

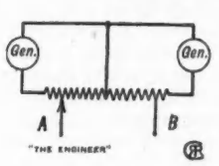
The side tanks and bunker are built of welded steel plates, the water capacity being 2000 gallons and the bunker capacity 2½ tons of coal. Steam braking gear is fitted only to the coupled wheels of the locomotive, and a Dreadnought ejector and equipment is included for operating vacuum brakes on a train. The steam brake can be operated independently of or in conjunction with the train brakes, and has a driver's valve at each side of the cab ; a hand screw brake is linked with the rigging.

We are informed that operating reports show the six locomotives are giving consistently sound performance. Trains of forty to forty-six loaded wagons totalling 840 to 850 tons are being handled, and no difficulty is being experienced in hauling these loads round sharp curves. On one set of observations six hours of heavy shunting and short haulage with forty to forty-six wagons of 830 to 850 tons were completed on a coal consumption of 15 cwt and a water consumption of 1000 gallons, which supported the designers' contention that the 2000 gallons of water and 2½ tons of coal would be enough for twelve hours of hard work. On the above runs the wagons were loaded with merchandise, but with forty-five loaded coal wagons and five miscellaneous wagons, totalling 1042 tons, a cut-off of 65 per cent was found to be sufficient to do the work easily, and the chief mechanical engineer considered a load 25 per cent heavier could have been hauled.

Electric Sectional Drive

AN interesting form of electric sectional drive, developed by the Metropolitan-Vickers Electrical Company, Ltd., Trafford Park, Manchester, applies new principles to achieve the accurate speed control that is required of d.c. motors in a variety of industrial processes, such as papermaking, printing and linoleum manufacture. Using the existing motors and starting gear, the new system has already been applied to a large calender drive and the results, after six months' service, indicate that the equipment combines high sensitivity with stability and corrects speed fluctuations with the minimum of disturbance.

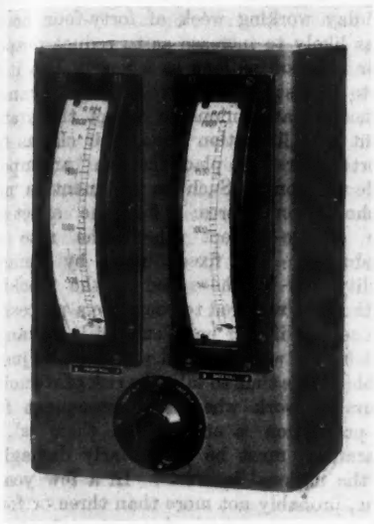
Fundamentally, the M-V control system is extremely simple, as indicated in our first illustration, which outlines the method of controlling a pair of motors. A small tachometer generator, producing a voltage proportional to its speed, is direct coupled to each motor, and the two outputs are connected in opposition across a potentiometer. If the two voltages developed are equal and the sliding contact A



PRINCIPLES OF NEW SECTIONAL DRIVE

is adjusted symmetrically in relation to the fixed connection B there will be zero voltage across AB. Any change in the speed of either motor, however, causes a corresponding change

in generator voltage to appear across AB, and this voltage is amplified and applied to one of the motor fields to restore synchronism. If a permanent difference in speed between the two motors is required, the sliding contact A is adjusted to give zero voltage across AB at the desired motor speeds; any variation in the relative speeds of the two motors then produces a voltage across AB, which restores the original speed relationship in the manner described above. The potentiometer, which may be

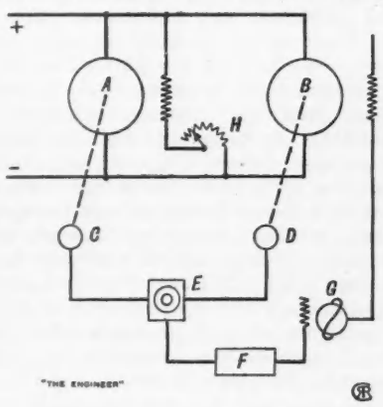


CONTROL STATION

calibrated in percentage speed difference, is mounted with the motor speed indicators to form a control station, as illustrated herewith.

To maintain the relative speeds of the two motors accurately within a fraction of 1 per cent under all conditions, the voltage signal across AB requires high amplification, which is effected in two stages. The first stage is an electronic amplifier, which forms a compact, self-contained unit employing hard valves of the kind used in ordinary radio receivers. The second amplification stage is a Metadyne generator, which, as is well known, requires only a minute exciting current and gives an extremely rapid response to changes in excitation; it is therefore a suitable link between the output of the electronic amplifier and the field of the main motor.

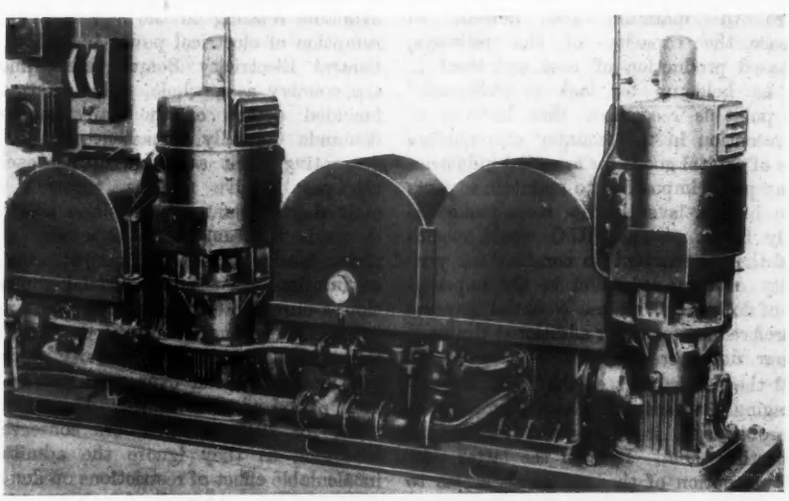
In the case of the calender drive installation which is illustrated in an accompanying engraving, each section is driven by a 25 h.p. variable-speed d.c. motor designed to give a speed range of over 3 : 1 by shunt field control. Bearing in mind the fact that the motors were of standard design, the problem of obtaining the required sensitivity and stability over the full shunt range was not an easy one. Though the basic speed of the calender was not critical, the relationship between the speeds of the motors was extremely critical. It was therefore decided to leave one motor under manual control and to design the control equipment so that the second motor should follow the speed of the first. It is true that with this system any inadvertent speed fluctuations of the leading motor are



SCHEMATIC DIAGRAM OF CONTROL SYSTEM

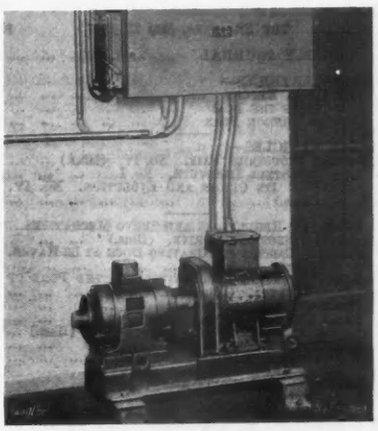
followed by the controlled motor, but it is much simpler and less costly than the elaborate scheme that would be required to control the speeds by linking each motor to a common reference.

The control system that was finally adopted is shown schematically on this page. The leading motor A and following motor B are fitted with voltage generators C and D. The leading motor is controlled by the field rheostat H. The potentiometer E provides for relative speed adjustment and the electronic amplifier F and Metadyne generator G apply the control voltage to the shunt field of B. In the illustration showing the lay-out of the calender drive the voltage generators are seen mounted on top of the vertical spindle main motors, while the control station and field regulators are on the extreme left. Another illustration shows the Metadyne generator together with a portion of the sheet steel cubicle, which encloses the associated speed control and starting gear.



LARGE CALENDER EQUIPPED WITH SECTIONAL DRIVE

It should be emphasised that this installation is only a particular instance of a system that is extremely flexible in its application. For example, the speed of a single motor with either shunt field or armature voltage control can be stabilised by coupling a voltage generator to the motor shaft and backing its output against a voltage reference. Where several



METADYNE GENERATOR

motors are used their speeds can be referred to a common standard or they can be cascaded as in the calender drive described; for wide speed ranges armature control would normally be used with a limited range of shunt field control on the individual motors for trimming purposes.

Automatic Regulators and Servo Mechanisms

MR. JOHN WILMOT, H.M. Minister of Supply, addressed a large audience on Monday, May 19th, at the opening meeting of the convention on automatic regulators and servo mechanisms held by the Institution of Electrical Engineers, Savoy Place, London. Mr. Wilmot emphasised the importance of the "servo panel," which was set up during the war to co-ordinate the various applications of servo mechanisms between the three Services. By eliminating the human element, servo mechanisms helped to increase the efficiency of anti-aircraft artillery; they made possible the defeat of the flying bomb, and they formed an essential part of "George," the automatic pilot. There were numerous other wartime applications of servo mechanisms, many of which were to be discussed in papers presented to the convention, but this was merely a chapter, for the quality of service defence equipment depended upon the continued and extended use of these devices. Turning to the no less important peacetime uses of automatic regulators and servos, Mr. Wilmot pointed out that automatic methods could increase output in many industries. To illustrate the diversity of possible applications of these methods in modern industry, Mr. Wilmot quoted a few examples. The manufacture of synthetic rubber required precise control of a sequence of operations that could not be achieved by manual methods. Many other processes in chemical engineering, including the production of synthetic materials such as vitamins, plastics, and artificial silks, offered promising scope for automatic methods. Servo mechanisms form a vital component not only in guided missiles but in pilotless aircraft, which would prove to be invaluable for advanced research into the aero-dynamic and control problems associated with flight at sub-sonic and supersonic speeds.

THE FUKIEN-KIANGSI RAILWAY.—The Chinese Ministry of Communications has sent four surveying teams to investigate the preliminary work for the construction of the Fukien-Kiangsi Railway. The line will be 518 miles long and will link Amoy with Yingtan, *vid* Foochow, Nanping and Kwangtseh.

THE ENGINEER

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NOTICE TO READERS

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THE T.U.C. REPORT

WE find it unexpectedly difficult to give to the T.U.C. Report on the "Economic Survey for 1947," published last week, the thoughtful consideration that it really merits. It may be merely that spring has arrived after one of the hardest winters in living memory and that our thoughts are set upon impending holidays with their freedom from the consideration of national economic cares. More probably the lack of provocation to thought arises because, after the stir of the fuel crisis which brought home to everyone in the country the reality of the economic facts, further T.U.C. comment upon the White Paper comes rather in the form of an anti-climax. Moreover, in general, though not wholly, the present report is little more than an amplified version of the preliminary report issued by the T.U.C. soon after the publication of the White Paper and commented upon in these columns in our issue of April 4th.

But, rather curiously—perhaps because it discusses more vigorously than the White Paper itself the means whereby productivity can be raised and shortages reduced—the T.U.C. Report seems to reveal even more clearly than other such documents the reality of this country's economic dilemma. For the reader is kept aware throughout of those two severely competing demands upon our productive resources, to provide sufficient material for exports and at the same time to modernise our industrial equipment so that substantially more can be produced by a labour force no greater than that at work or available for work before the war. More machinery is needed in the coal mines for cutting, loading, carrying and cleaning and grading coal; without more generating plant in our power stations the output of industry must be restricted by winter power cuts; and if lack of transport is not to impose a bottleneck on productivity the railways must more rapidly be supplied with locomotives, trucks and permanent way equipment. Yet if we divert to re-equipment at home too much of our productive resources inevitably our rate of export must for a time be diminished with the short-term consequence that dollar credits must the more rapidly be drawn upon. There is, too, the longer term risk that the goodwill of overseas markets may be lost and become difficult to regain when, in later years, the market has become more favourable to the buyer than to the seller. Nor can other industries less concerned with the production of goods urgently needed in this country be relied upon for a compensatory expansion of their exports. For shortages of coal, steel and power set an upper limit to total productive capacity. The basic argument of the T.U.C. Report is that attention should be concentrated now upon raising the output of coal and power and increasing the capacity of the railways, without which no significant expansion of general productivity can take place. The coal target for 1947, it is contended, should be 220 million tons, not 200 million. "The T.U.C. cannot contemplate the continuation for a further two or three years of the economies and temporary arrangements for shedding the electricity load at present imposed on us by shortages of fuel and power." And upon transport the Report remarks "Unless something is done in the very near future to maintain and, indeed, to increase the capacity of the railways, increased production of coal and steel ... will be held up for lack of transport." The point is recognised that because of the retention in this country of manufactures of capital goods for essential industries it may prove impossible to maintain exports at so high a level. The consequence is boldly faced. "The T.U.C. would recommend the Government to consider the possibility of some reduction in the expenditure of dollars on our less essential imports in preference to further additional drainage on our dollar credits."

All the earlier part of the Report is encouragingly vigorous in its recognition of the problems and its suggestions of the means of meeting them. It is in the latter part that perception of the real needs seems to fade. Recognition is accorded to the fact that the existing distribution of our limited manpower cannot be defended. But recommendations for bringing about an improved distribution descend into vagueness. "It is clear that efforts should be made—by way of special restraints or discouragement upon less essential industries and by some encouragement to workpeople to move into essential industries—to improve the distribution of manpower." No suggestions are made as to what these "restraints" and that "encouragement" should be, though probably the withholding of priorities and the creation of wage differentials is hinted at. Further, the objection, emphasised in the earlier comments of the T.U.C. on the White Paper, to the statement that "the nation cannot afford shorter hours of work unless these can be shown to increase output per man-year" is amplified. Experience, it is claimed, has shown that a five-day working week of forty-four hours is as likely to increase as to reduce output over a period as long as a year. But it is quite impossible to prove this in advance. Hence, to ask unions to accept the statement as a limitation upon their claims for shorter hours is to place them in "an impossible position." Such an argument is not without some force. For the effect of the change—except where the rate of production is fixed not by man's ability but by the speed of the machine or the time required to complete a process—can seldom if ever be calculated in advance. But it may well be asked whether it is justifiable at this time to take the risk of reducing hours of work when any consequent fall in production, against which there is no guarantee, must be particularly damaging to the national interest? In a few years' time, probably not more than three or four, it is reasonable to hope that serious shortages will be a thing of the past. The claims of unions for shorter hours of work would then more readily obtain a sympathetic hearing.

STAGGERING THE ELECTRICAL LOAD

THE measures required to reduce peak industrial loads on the electricity supply systems are examined and discussed in a report issued recently by the Electricity Sub-Committee of the Joint Consultative Committee of the National Joint Advisory Council. To assist the Sub-Committee in its deliberations, basic information was made available relating to the supply and consumption of electrical power in each of the Central Electricity Board's areas and in the country as a whole. This information included details of the daily maximum demands actually experienced and the generating plant available during each of the past twelve months, together with estimates of plant capacity and maximum demands that might be expected in the next twelve months, subject to the assumptions that non-industrial consumption is unrestricted; that domestic supplies of solid fuel remain unchanged; and that the scale of industrial activity and the distribution of load over each twenty-four hour period are maintained. The estimates made for 1947 are therefore conservative inasmuch as they ignore the admittedly incalculable effect of restrictions on domestic consumption. With the foregoing assumptions it is estimated that industrial consumers will take 49·1 per cent and domestic users 33·7 per cent of the total electricity consumed in 1947, and that these two categories jointly will consume some 1¾ million units more than in 1946.

In its analysis of the problem, the report distinguishes between the difficulties that may arise through shortage of plant during the coming summer

and the much more severe difficulties that must be anticipated next winter. It is recognised that a temporary reduction in the available generating capacity is unavoidable in the summer, which provides the only opportunity for major overhauls in preparation for the winter load. The gap between available plant and maximum demand gradually closes between January and July, but the risk of load-shedding between the hours of 8 a.m. and 9 a.m. during the summer months cannot be eliminated completely. During the coming winter plans and estimates must, if breakdown is to be avoided, take account of the effects of severe weather. Whilst the facts are continually under review, present indications are that from October next the demand will have to be reduced in such a way that the peak industrial load between the hours of 8.30 a.m. and 4.30 p.m. does not exceed two-thirds of the corresponding peak load during 1946–7. To reduce the risk of load-shedding during the summer and to effect the necessary drastic cut in winter consumption with the minimum of dislocation to industry involves measures to transfer some of the industrial load to off-peak hours. The report has no new suggestions to offer as to how the transfer can be accomplished. It recommends only that the Regional Boards for industry should make arrangements, without delay, for introducing such changes as the staggering of day shifts; extending night-shift working, particularly to those industries that involve processes demanding a heavy electrical load and employing comparatively few workers; and the operation of rota schemes on a geographical basis. The report goes on to suggest that industries should employ the appropriate negotiating machinery to settle the terms and conditions involved in the revised working hours under the proposed new arrangements.

Since severe restrictions appear to be unavoidable little fault can be found with these somewhat obvious recommendations. But difficulties appear to loom in the way of their implementation—difficulties that are inherent in the sociological changes implied in the proposals. Many of these difficulties are foreseen in the Sub-Committee's report. Modifications to the Factory Acts are envisaged and wage-rate changes anticipated, but it is the negotiating machinery that will have to bear the unenviable burden of resolving these problems. Although no clear indication has yet been given of the undoubtedly differing attitudes of employers and unions to these proposals, it would be unreasonable to expect immediate universal agreement as to their implications. For unless the problems surrounding wage adjustments are to prove insuperable, it seems probable that a fresh conception of the meaning of "overtime" will have to be found for double day-shift working as well as for night work. There may, too, be some difficulty in reconciling the interests of the various unions concerned in each of the Regional Board areas and of co-ordinating the Boards' decisions if the unions desire, as they well may, to ensure uniformity of treatment for their members throughout each individual union regardless of area. In mentioning such problems we do not wish to exaggerate their importance. With goodwill upon both sides and the evidence in the T.U.C. Report on the "Economic Survey for 1947" that the unions are as well aware of the economic situation of this country as are the employers, we believe they can be satisfactorily solved. But their existence lends further point to the T.U.C. contention, mentioned in another article on these pages, that "the continuation for a further two or three years of the economies and temporary arrangements for spreading the electricity load" cannot be contemplated.

CITY OF LONDON PLAN

No doubt because we are Londoners, we take a deeper interest in the City of London Plan, published this week, than engineers in other cities and in other lands may feel disposed to show. It is a Plan, we admit, of greater importance to architects and town-planners than to engineers. Yet so much is it true that without the works of engineers no great modern city could continue adequately to perform its functions that the rebuilding and the reorganisation of the central part of the greatest city in the world does not in reality lack a certain interest for engineers. Indeed, we recommend to engineers a study of the whole report as an example of the complexity of the matters that have to be considered in planning an old city to carry new traffics and to contain new buildings. Naturally enough, however, there are certain portions of the report that especially attract technical attention. We refer, not only to road lay-out, a matter which is becoming almost as much one for specialists as town planning itself, but also to the provision of rail connections and of underground services. The new Plan in its longer-term, thirty-year, aspect is based, it seems, upon the supposition that the recommendations of the Railway (London Plan) Committee will be carried out. The proposals of that Committee, it will be remembered, were of a somewhat remarkable character, envisaging the connection below ground of full-scale railways on several routes from north to south and east to west. The estimated expense was very great and the advantages to be gained, though undoubtedly large, were somewhat dubious in relation to that high cost. To base part of the City Plan on proposals which may never achieve reality is, we fear, to found it rather insecurely.

On technical matters the consultants who drew up the Plan, Dr. Holden and Professor Holford, do not feel competent to venture many remarks. They do point out, however, that "there is an unprecedented opportunity" for the extension of the use of subways for service pipes "along the sites of new roads in cleared areas" where "the building of the road partly over what is now derelict basement space would allow for the suspension of essential service mains below the carriageway during the construction period and their enclosure in standard subways when the buildings are erected and the footways laid." Nor are their references to a district heating scheme, suggested by Mr. Donkin, the consultant to the City on that subject, without interest. It is proposed that heat should be generated in two or three power stations outside the City boundary (including, incidentally, the new Bankside power station) and that there should be flow and return hot water mains to one or more accumulator stations in the City, from which 16in hot water mains would carry the water to service points in each building. Dr. Holden and Professor Holford are more particularly interested in the consequence of such a scheme that coal carts and lorries would be eliminated from the streets and that the City "would set an example to the rest of London in reducing the smoke nuisance at its very centre." Engineers will be more concerned with the technical particulars. Meagre details are mentioned in the Plan including the estimate that the cost of heat to consumers would be substantially reduced. We hope that there will not be long to wait for the full publication of Mr. Donkin's report upon the project.

Obituary

SIR FREDERICK CHARLES COOK

IT is with regret that we record the death of Sir Frederick Cook, eminent civil engineer and President-elect of the Institution of Civil Engineers. He died at his home, "The Mount," Ashtead, Surrey, on Thursday of last week, May 15th, aged 72. He was an expert on road engineering and was for many years in the Ministry of Transport, retiring from the position of Chief Engineer (Highways) at the end of 1942. After his

SIR FREDERICK COOK

retirement he joined Messrs. Howard, Humphreys and Sons, Civil Engineers, Westminster, and continued with road schemes until his death.

Frederick Charles Cook was born on April 22, 1875. He received his early education at New College, Worthing, and studied engineering at Brighton Technical School. In 1894 he completed a three-year practical training under the late Mr. Miles Aspinall, A.M.Inst.C.E. For the next twenty-five years, broken only by the 1914–18 war, he served continuously in municipal posts, starting as junior assistant to the borough surveyor of Worthing, followed by a period as engineering assistant to the borough surveyor of Hove, during which he was engaged on the Medina Esplanade extension, main drainage schemes and sea

defences. For many years he was borough surveyor and water engineer to Nuneaton, and was responsible for numerous schemes for improving the sewage, water supply and flood prevention works of that borough. He widened his experience and served with distinction in several other municipal posts.

In 1915 he was on active service, in command successively of Army Troops and Field Companies, Royal Engineers, being awarded the D.S.O., M.C. and Croix de Guerre.

Returning to civil duties, Frederick Cook was appointed in 1919 city engineer to the county borough of Oxford, where he had charge of all the engineering work of the city, including roads and bridges. In 1920 he took the post of engineering inspector in the Ministry of Transport and became divisional engineer for the Midland division in 1921, deputy chief engineer in 1929, and chief engineer in 1935, retiring from the last-named post, as already mentioned, in 1942.

The period in which Sir Frederick Cook was with the Ministry of Transport saw many important advances in road engineering, notably the construction of the first arterial roads with dual carriage ways and cycle tracks, the Restriction of Ribbon Developments Act and the Trunk Roads Act of 1936, whereby 4500 miles of trunk roads were transferred to Ministry control. During this period he served on many committees and initiated much experimental work in conjunction with the Road Research Board of the D.S.I.R. He will perhaps be best remembered as chairman of the Departmental Committee on Design and Lay-out of Roads in Built-Up Areas, whose excellent report was published in January, 1945. He was also chairman of committees on street lighting and traffic signs.

From 1943 until his death he was with Messrs. Howard, Humphreys and Sons, and was associated with road schemes for Breconshire County Council and with various water supply and sewerage schemes.

Sir Frederick Cook was made C.B. in 1937 and a Knight in 1942. He was a valued member of the Institution of Civil Engineers, becoming a Member of Council in 1935. He was a Fellow of the Surveyors' Institution and an Honorary Member of the Institution of County and Municipal Engineers. He contributed numerous papers on road construction, design and safety to the Institution of Civil Engineers, and papers on by-laws relating to new streets and road policy to the Institution of Municipal and County Engineers.

Sir Frederick Cook was a modest man with many gifts, and many engineers will regret his passing.

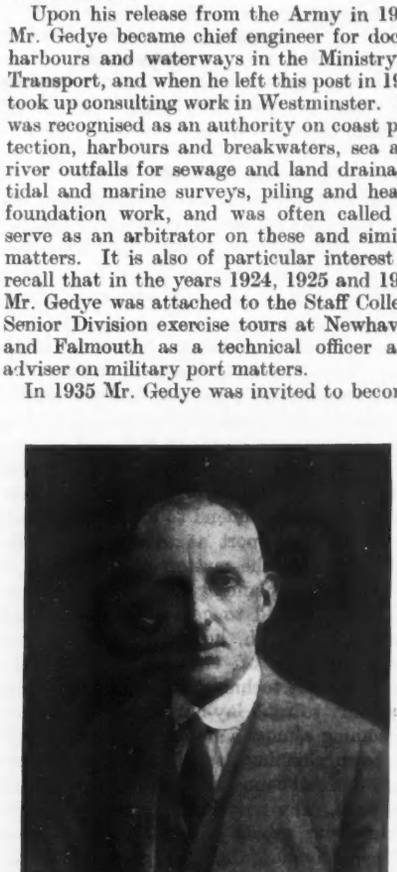
NICHOLAS GEORGE GEDYE

It is with a sense of personal grief that we have to record the death on May 19th of Mr. Nicholas George Gedye, who for a number of years has frequently contributed to our columns articles dealing with those aspects of civil engineering in which he was an expert.

Nicholas Gedye was born at Bristol in 1874, and was educated at Bristol Grammar School and at the University of Birmingham. The early years of his civil engineering career were spent with the late Mr. W. T. Douglas, whose assistant he became in 1896, and with whom he was engaged principally on the design and construction of lighthouse apparatus for the Colonies and other overseas countries. Some years later, Gedye was appointed chief engineer to the Tyne Improvement Commission, a position which he relinquished in 1915. In the following year he joined the Royal Engineers, of which he was a Lieutenant-Colonel, serving in France and Belgium during the first world war. For his war service he received the O.B.E. and was also made an Officer of the Belgian Order of the Crown.

Upon his release from the Army in 1919, Mr. Gedye became chief engineer for docks, harbours and waterways in the Ministry of Transport, and when he left this post in 1921 took up consulting work in Westminster. He was recognised as an authority on coast protection, harbours and breakwaters, sea and river outfalls for sewage and land drainage, tidal and marine surveys, piling and heavy foundation work, and was often called to serve as an arbitrator on these and similar matters. It is also of particular interest to recall that in the years 1924, 1925 and 1926 Mr. Gedye was attached to the Staff College Senior Division exercise tours at Newhaven and Falmouth as a technical officer and adviser on military port matters.

In 1935 Mr. Gedye was invited to become



NICHOLAS GEORGE GEDYE

the British Government's representative on the Permanent International Commission of Navigation Congresses, and he was also the British National Committee's permanent delegate to the International Commission on Large Dams. Soon after the war began in 1939, Gedye joined the staff of the Regional Commissioner for South-West England, and from October, 1940, was Regional Works Adviser. Towards the end of 1945 he made a tour of the western zones of Germany to study developments in dock and harbour construction, to enable a report to be prepared for the British Intelligence Objectives Sub-Committee. The Home Office released him from this appointment in July, 1946, thereby enabling him to resume his consulting practice.

Mr. Gedye was a member of the Institution of Civil Engineers and made several contributions to its "Proceedings," including the Vernon Harcourt Lecture in 1932 on "Mechanical Handling of Coal at Ports." He was also a member of the Association of Consulting Engineers, of which he was Chairman in 1931, and in 1936 was one of the British Government's delegates to the World Power Conference in Washington. Amongst Mr. Gedye's technical writings, mention must be made of his contributions to "Encyclopædia Britannica," 1929, on Docks, Harbours, River Engineering and Coast Protection. These, like his papers and lectures to institutions and international congresses, and like his articles in THE ENGINEER, were marked by the clarity of his style and the lucidity with which he presented his opinions.

SIR THOMAS McPHERSON

The British shipbuilding industry has lost one of its prominent personalities by the death of Sir Thomas McPherson, chairman and general manager of the Wallsend Slipway and Engineering Company, Ltd., which took place on May 19th.

Thomas McPherson was born at Sunderland in 1872, and after serving his apprenticeship with George Clark and Son, Ltd., went to sea for sixteen months as a junior engineer in the Merchant Service. Subsequently, he went into the drawing-office of William Doxford and Sons, Ltd., where he was employed from 1895 until 1898. In October, 1898, Sir Thomas entered the service of the Wallsend Slipway and Engineering Company, Ltd., first of all as a leading draughtsman, and after a period as assistant chief draughtsman was appointed chief draughtsman in 1918. During much of his earlier service with the company he acted as personal assistant to the late Mr. Andrew Laing, with whom he was jointly responsible for the design and construction of the main machinery of the "Mauretania."

When Mr. Laing died in 1931, Sir Thomas was appointed general manager of the Wallsend Slipway and Engineering Company, Ltd., and a year later he was elected a director. He became chairman of the company in March last.

Sir Thomas, who was knighted in the 1947 New Year Honours, was a member of the Technical Committee of Lloyd's Register of Shipping and was a Fellow of the North-East Coast Institution of Engineers and Shipbuilders.

SIR THOMAS HOLLAND

Mining engineers and geologists among our readers will have learned with deep regret of the death of Sir Thomas Henry Holland, which occurred on May 15th, at his home at 54, Chiltern Drive, Surbiton. During a distinguished career, he served as Director of the Geological Survey of India and as Commerce Member of the Viceroy's Executive Council, and by his work in both these offices made a valuable contribution to the industrial development of India.

Sir Thomas, who was the son of the late John Holland, of Springfield, Canada, was born at Helston, Cornwall, in 1868. He became an associate of the Royal College of Science at the age of twenty, and a year later, in 1889, gained a Berkeley Fellowship at Owen's College, Manchester. In 1890, Thomas Holland joined the staff of the Geological Survey of India, and was appointed Director in 1903, a position which he occupied until 1909. During the years in which he was responsible for the work of the Survey, a detailed review of India's mineral industries was carried out, and the information thus gained was undoubtedly of great value in the later development of the country's mineral resources. Amongst other offices held by Sir Thomas while in India were President of the Mining and Geological Institute of India and President of the Burma Oil Reserves Committee. He was also a Fellow and Reader of Calcutta University.

In 1909, Sir Thomas returned to England

to become Professor of Geology and Mineralogy in the University of Manchester, but his work for India was resumed during the 1914–18 war, when he presided over an Indian Industrial Commission and also served on the Board of Munitions for India. In 1920–21, he was a member of the Governor-General's Council, having been created Knight Commander of the Star of India in 1918.

In 1922, Sir Thomas received and accepted an invitation to become Rector of the Imperial College of Science and Technology, an office in which he served with energy and distinction until 1929. In that year he succeeded the late Sir Alfred Ewing as Principal and Vice-Chancellor of the University of Edinburgh. Here again he rendered devoted service until his retirement in 1944.

In addition to the many responsible positions which Sir Thomas occupied during his working life, he was always ready to give of his time and talents to help the work of numerous learned societies. He was, until recently, a Vice-President of the Royal Society, was a Past-President of the British Association, the Institution of Mining Engineers, the Institute of Petroleum and of the Mineralogical Society of London. He was also an Honorary President of the Royal Scottish Society of Arts, a Trueman Wood Lecturer of the Royal Society of Arts, and a Huxley Memorial Lecturer of the Imperial College of Science.

It must be added that Sir Thomas was a man of very outstanding personality, who enjoyed great popularity in the circles in which he moved. His ready wit and lively conversation will be greatly missed by all who knew him as a friend.

Literature

Civil Aviation and The Export Trade. By Squadron Leader NORMAN J. FREEMAN (Institute of Export). Price 6s. 6d.

THIS little book is described by its author as a presentation of facts, figures and ideas designed to assist "the student of export" in an approach to the subject of civil aviation. The "ideas" suggested may perhaps represent the best thought of the day, but, inevitably, the "facts and figures" relate to the civil aviation of ten years ago rather than to post-war construction and technique under the conditions of to-day. It is surprising, nevertheless, that the author should quote without comment the 1937 figures for the "Railway Associated Air Services," which show as little as 1,004,000 aircraft miles as having been flown by a fleet of twelve aircraft; this corresponds to only 84,000 miles a year per aircraft—a considerable contrast with the U.S.A. mileages flown by some of its internal airlines of 400,000 miles (and even more during the war years), and much below the former "Imperial Airways" figure of over 130,000. When making estimates for future world services, a figure of at least 200,000 should be the aim, especially if fares are to be brought down to the author's estimate of threepence per passenger mile, itself no impossible figure, with the American lines offering a fourpenny rate even for the double Atlantic crossing.

As to taking cargo by air, the author frankly admits that his estimate of a shilling a ton-mile compares very unfavourably with shipping rates, which may sometimes be but a small fraction of a penny, and he quotes Dr. Warner's remark that even if air cargo traffic should rise to ten times its pre-war volume it would still carry but a tiny fraction of the vast mass borne by the merchant navies of the world.

Financing civil aviation is not likely to become any easier in the coming years since the cost of aircraft construction is shown to have increased markedly over the past decade. In the pre-war years large British aircraft cost but twenty shillings a pound to build. From figures given by the author for current types it appears that to-day's figures are rarely less than thirty shillings in Britain, and may be forty or even more in U.S.A. The author concludes with a forecast of the probable position twenty years hence, but although he does not refer to future constructional costs, he does expect fares to fall to the neighbourhood of three halfpence a passenger-mile with speeds of flight so greatly enhanced as to enable Australia to be reached in less than 24 hours.

IF this small volume the author has packed much technical and business information, which will prove useful not only to those students to whom it is mainly addressed, but to many others as well.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

L.M.S. DIESELS

SIR,—With reference to the correspondence regarding diesel locomotives, I feel that Mr. Brian Reed is not very appreciative of the many firms and individuals who, from my knowledge, have spent so much money, time and energy in an endeavour to produce a competitive mechanical transmission system. In addition to the overheating difficulty mentioned by Mr. Ivatt, there is with electrical transmission the added objection that the railway company has to face the addition of an electrical engineering repair and maintenance organisation.

No engineer would be right in advocating electrical transmission if it could be avoided, but the characteristics of the diesel engine, namely, its speed/torque characteristics and its critical speeds, and, in addition, its inherent physical relationship to the locomotive structure and driving axles (particularly in the larger sizes), create a formidable problem. Efforts ought to be continued to find an alternative solution, but the problem should not, in all fairness, be underrated.

It is noteworthy that the L.M.S. consider the experiment with main line diesel-electric locomotives worth while in spite of these disadvantages, and interested engineers will be glad to note that they are adopting a reasonable policy (for which they are too often criticised) and not attempting to attain the last word in power/weight ratio before they have gained experience on more conservative lines.

In this connection, the question of adequate braking for freight working has to be considered; my experience with an 880 h.p. diesel locomotive operating experimentally on main lines in this country before the war emphasised this aspect. As a result of experience, the railway company was forced to stipulate that a specified number of braked vans must be coupled to the locomotive, when working heavy freight trains, so that the braking would be equivalent to the steam locomotive normally used for that service. The locomotive was of the 2-C_o-2 type (power/weight ratio 183 lb per b.h.p.) and was easily able to maintain the time schedule; an improvement to the locomotive could have been made by fitting brakes to the carrying axles, but the experience does seem to indicate that braking consideration for mixed-traffic locomotives may make any substantial further reduction in power/weight ratio undesirable.

D. J. WATKINS.

Newcastle-on-Tyne, May 19th.

CONDENSATION BY COMPRESSION

SIR,—In his letter of May 3rd Mr. Holcroft seems to consider the severe criticism in your journal of his article to have been unjust. But such revolutionary and far-reaching claims as he made need much stronger evidence to support them than that produced. The actual facts were that on the "Anderson" system a continuous test, of which no other details were available, had shown a saving of 29 per cent in actual coal consumption, and a short repeat test, for which a few details were given, had produced similar results. The actual consumption of a steam plant for a given useful power output, however, depends on the boiler and engine efficiencies, as well as on the feed and condensing arrangements. No attempt was made to measure these, and it was rashly concluded that the entire saving was due to the "Anderson" system of operation, and hence that the exhaust steam behaved in a manner inconsistent with current theories. In such circumstances, criticisms were only natural.

It is gratifying to note that Mr. Holcroft now admits that the "Anderson" system should be subjected to scientific investigation, "as should have been done in the first place," and that "no amount of manipulation of figures on paper will prove anything one way or the other."

F. P. FROST.
S. LABROW.

Stockton-on-Tees, May 14th.

[Since Mr. Holcroft and Messrs. Frost and Labrow are now agreed that "no amount of manipulation of figures on paper will prove anything one way or the other," this interesting correspondence has clearly come to an end until such time as the "Anderson" system is scientifically investigated.—ED., THE E.]

SUMMER COAL SUPPLIES

SIR,—Your sub-leader of May 9th, on the subject of coal clearly sets out the situation as it appears from figures officially supplied.

It has long been the custom of engineers to refer to saturated steam as "stuff" and I think this term might be conveniently applied to the adulterated coal which is now reaching industry. Up and down the country evidence is not lacking that the percentage of incombustible has increased considerably. In some instances there is 300 per cent more ash than before and in the best of cases it is about 200 per cent; the housewife even will testify to this. Now, if this extra adulteration is to be called coal, we are indeed deluding ourselves: not only does it produce no heat but in many cases it has a deleterious effect upon heat exchanging elements—more often than not a boiler and the availability of boilers has been very much impaired through this cause. Moreover, foundries are called upon to provide replacement parts at a rate greater than normal, at a time when the founding industry is so hard pressed that ordinary work is well behind schedule.

It might have been better, therefore, if you could, in your survey, have alluded to, even if you could not have made a computation of, the effect of this. To-day, many people—the Government in particular—seem to turn away from ugly facts; we will not as a country recover our position by so doing.

A. HOARE.

Cowes, May 19th.

Stress Analysis by Polarised Light

ALTHOUGH the principle of observing distribution of stresses throughout a loaded object by passing polarised light through a transparent model was established almost forty years ago, its application has been confined until recently almost entirely to the physics laboratory. Hitherto the probable maximum stresses of a new component have been computed almost exclusively by mathematical means, a practice which in many cases is tedious and in others impossible of reliable result, because of the complicated shape of the component or because of the intractable nature of the mathematical problem. An alternative is to make a number of assumptions and to use empirical formulæ, together with a generous safety factor. Here the designer may grossly over-estimate the working stress and produce an uneconomical component, or, conversely, by under-estimation of the stress the component may fail mechanically. It is therefore apparent that a more accurate means of stress analysis would increase the reliability of engineering products and would in some cases have a profound effect on their design and cost of production. This is particularly so in the case of highly-stressed components, such as are common in the aircraft and automobile fields, and for cutting tools.

It is therefore with considerable interest that we note that David Brown and Sons (Huddersfield), Ltd., of Park Works, Lockwood, Huddersfield, has designed and constructed equipment for such analysis in the form of an instrument designated as a "Polariscope." This equipment, described and illustrated below, has been in use for some time in the firm's Park Works research department, and has, we understand, given much valuable information to the firm's design staff. The Polariscope lends itself admirably to the study of stress concentrations in gear teeth and the determination of suitable tooth proportions.

Principle of Operation

Remembering that light travels in wave form, a beam of ordinary white or monochromatic light can be thought of as a series of vibrations in any number of directions transverse to the direction of the beam. It is possible to dampen or to eliminate all vibrations except those parallel to one plane, when the light is said to be plane-polarised.

If plane-polarised light is passed into models made of a suitable transparent plastic material, such as phenol-formaldehyde resin, it splits into two rays vibrating in the directions of the principal stresses, but at different velocities (see diagram above) a phenomenon known as double refraction. When these two components after emerging from the model are recombined by passing the light through an analyser, interference takes place if they are out of phase; an image of the model projected on to a screen will reveal this interference as a series of brightly coloured lines intersecting the image. These lines are known as isochromatics, and if a monochromatic light source is used they are shown as black lines only. The extent to which the two light components are out of phase at any point in the model depends on the amount of retardation of each of the two at that point, which in turn is governed by the magnitude of the two principal stresses at that point.

When the plane of incident polarised light coincides with the direction of one of the principal stresses the light passes straight through the model and is cut out by the analyser, resulting in a black line on the screen. Lines of this nature are known as isoclinics and are useful for determining the directions of the principal stresses. If isochromatic lines only are wanted, the isoclinics may be removed by using a quarter-wave plate on either side of the model

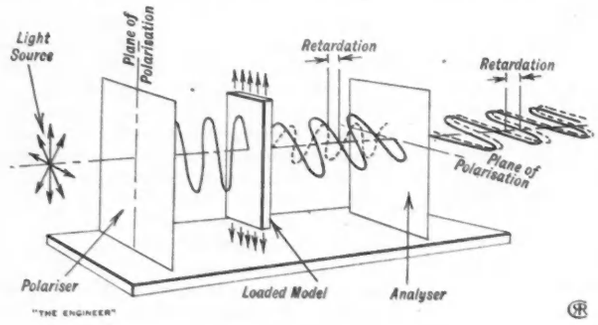
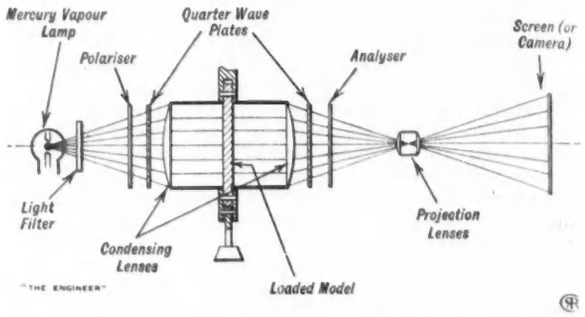
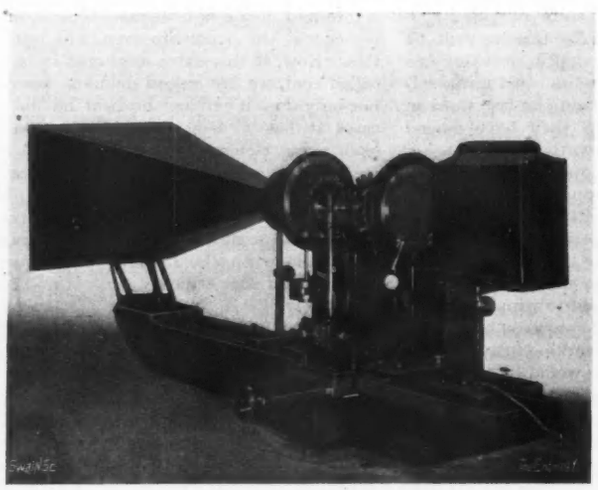


DIAGRAM OF OPTICAL THEORY

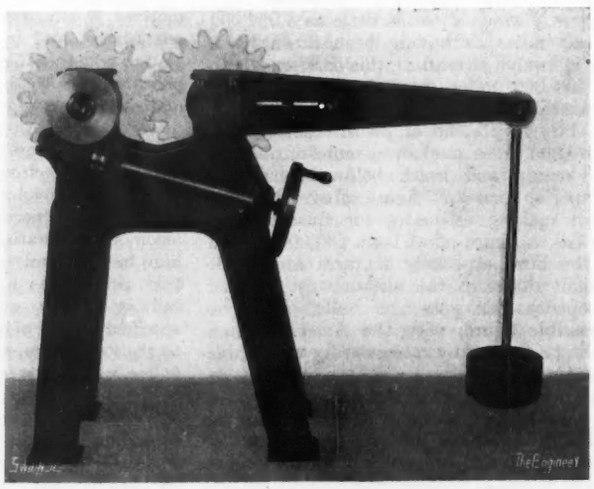


DIAGRAMMATIC ARRANGEMENT OF POLARISCOPE

STRESS CONCENTRATIONS IN GEAR TEETH



POLARISCOPE SET UP FOR TEST

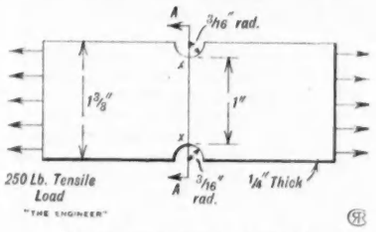


STRESS FRAME FOR LOADING GEAR MODELS

between the polariser and analyser, a quarter-wave plate being a plate of double-refracting material which retards the light components by one-quarter of a phase.

Polariscope

The arrangement of the Polariscope made by the David Brown research department is shown diagrammatically and by means of the photograph of the actual equipment reproduced opposite. The polariser and analyser are almost identical in design, each consisting of a 6in diameter sheet of Polaroid and a mica quarter-wave plate mounted in circular holders. Either may be rotated through 360 deg., the rotation being measured by graduated scales. The quarter-wave plates are readily detachable. Two con-



Component with Fillets

densing lenses, each of 12in focal length, are used. If photographic records are required, the ground glass screen is replaced by a camera. Illumination is by a 250W mercury vapour lamp mounted in a lamp house bearing an adaptor to carry the filter that is necessary when monochromatic light is wanted.

The frame in which the transparent model is subjected to stress is carried on an adjustable table between the condensing lenses. A stress frame for loading gear models is illustrated herewith; a universal stress frame has also been designed, which can be adapted to produce tensile, compressive or bending stresses.

Stress Analysis Procedure

To make a stress analysis, loads proportional to those acting on the real object are applied to a model made to scale out of a suitable transparent material and the patterns of isochromatics and isoclinics viewed in the Polariscope. A typical pattern obtained with monochromatic light is shown on the opposite page.

Isochromatic lines being dependent on the magnitude of the principal stresses in the model and isoclinic lines giving the directions of the principal stresses, the designer can determine from them the stresses at any given point in the model and, consequently, in the actual component. Much can be learned by visual observation of the isochromatics alone. Just as crossing the contour lines on a map will indicate an obverse or reverse gradient, so crossing the isochromatic lines indicate movement from a region of low stress to one of high stress, and *vice versa*. A sharp change of stress value is indicated, therefore, by a concentration of isochromatic lines; thus, the pattern reproduced shows that the stresses in each of a pair of gears in contact are concentrated at the tooth fillets and at the point of contact. The stress distribution in similar models will be the same regardless of the material of which the model is made, provided, however, that only elastic stresses are considered.

A simple example of the possibilities of photo-elastic stress analysis is provided by an examination of a component similar to the one illustrated above and subjected to the loading conditions specified. To ascertain the maximum tensile stress in such a component most designers would select the minimum cross-sectional area (*i.e.*, on section AA) and divide the load by this area, thus obtaining a maximum tensile stress of 1000 lb per square inch. In other words, the component would be considered as if it were a plain strip in tension. But photo-elastic analysis proves that maximum tensile stress would occur at the two points marked *x* and would be as much as 2050 lb per square inch. The stress-raising influences of holes, grooves, fillets and other irregularities have, of course, been appreciated in the past, but little has been known about their numerical values.

One of the recent photoelastic investigations at Park Works into the stresses in gear rims gave two interesting conclusions: that the thickness of a rim may be reduced to a value equal to 0·6 of the circular pitch of the gear without appreciably reducing the breaking strength of the rim; and that the practice of securing a gear rim to a centre by means of grub screws does not appreciably reduce the strength of the rim, provided that the size of the grub screws is kept below a certain limit. It was seen that for each gear (neglecting the point of contact) the point of maximum stress was always at the fillet at the root of the non-contacting flank of a loaded tooth—or, in other words, the weakest point was at the compression fillet of a loaded tooth—reaching its height when the point of contact between the gears coincided approximately with their pitch point.

Water-Power Resources of Canada

The following review of the water-power resources of Canada and their utilisation presents the results, as at January 1, 1947, of an analysis of the potentially available and of the actually developed water powers of the Dominion, which is conducted annually by the Dominion Water and Power Bureau, Department of Mines and Resources, Ottawa. Canada's water power, of which at present only 20 per cent has been developed, has exercised a marked influence on the industrial development of the country and has been a primary factor in the growth of its great industrial capacity.

Available and Developed Water Power

The table herewith summarises the most recent computation by the Dominion Water and Power Bureau of the total amount of water power available, and of the capacity of water-power installations across the Dominion, by provinces. To obtain a dependable estimate of available power, all existing stream flow and power data available from federal, provincial and private sources have been systematically analysed and co-ordinated upon the uniform basis defined below. Developed power represents the manufacturer's rating of installed water turbines or wheels at designed heads.

Available and Developed Water Power in Canada January 1, 1947

Province.	Available 24-hour power at 80 per cent efficiency.		Turbine Installation h.p.
	At ordinary min. flow h.p.	At ordinary six months flow h.p.	
1	2	3	4
British Columbia	7,023,000	10,998,000	864,024
Alberta	507,800	1,258,000	93,060
Saskatchewan ...	542,000	1,082,000	90,835
Manitoba	3,309,000	5,344,500	446,825
Ontario	5,407,200	7,261,400	2,679,740
Quebec	8,459,000	13,064,000	5,848,572
New Brunswick ...	68,600	169,100	133,347
Nova Scotia ...	20,800	128,300	133,384
Prince Edward Island	3,000	5,300	2,617
Yukon and North-west Territory ...	382,500	813,500	19,719
Canada	25,722,900	40,124,300	10,312,123

The figures listed in columns 2 and 3 in the above table represent 24-hour power and are based upon rapids, falls and power sites, of which the actual drop or the head possible of concentration, has been measured or at least carefully estimated. Many unrecorded rapids and falls of undetermined power capacity exist on rivers and streams from coast to coast; these will become available for tabulation only as more detailed survey work is completed, particularly in the less explored northern districts. Also, unless definite studies have been carried out and the results made matters of record, no consideration has been given to the power concentrations which are feasible on rivers and streams of gradual gradient, where economic heads may be created by the construction of power dams. Thus, as regards possible heads, the listed figures of available power represent only the minimum water-power possibilities of the Dominion.

The power estimates of column 2 have been calculated on the basis of 24-hour power at 80 per cent efficiency, for conditions of "ordinary minimum flow," that is, on the averages of the flows for the two lowest periods of seven consecutive days in each year, over the period for which records are available. These figures show the estimated minimum continuous power ordinarily available at periods of low flow under existing conditions of river flow.

Estimates of dependable maximum power, column 3, are based upon the "ordinary six months flow," which is the computed dependable stream flow usually available for at least six months in the year. Although the maximum economic installation at any one site can be determined only by careful consideration of all conditions and circumstances pertinent to its individual development, generally it is considered to be good commercial practice to provide capacity to utilise the six months flow. In some cases, the deficiency in power during periods of lower flow is overcome by use of storage dams; in others by interconnection with other plants operating under different load conditions or which are located on other streams having different flow characteristics, or by auxiliary power from fuel plants. An analysis of the installed capacity of a number of those plants across Canada at which satisfactory stream flow data are available, shows that the average capacity of turbine installation is 30 per cent greater than the power equivalent of the six months flow. The listed estimates of maximum available power are therefore considered to have been made on a reasonable and conservative basis; also the total of 40,124,300 h.p. which represents the recorded water-power resources of the Dominion will permit of a turbine installation of more than 52,000,000 h.p.

The figures listed in column 4 are the totals of plant capacities computed on the manufacturer's ratings of the different units under the heads at which they are installed. For the purpose of determining the amount of undeveloped power, it is incorrect to subtract the figures of column 4 from the corresponding figures in columns 2 and 3, owing to the fact that total installed turbine capacity exceeds the six months flow power of developed sites by 30 per cent. The present total turbine installation of 10,312,123 h.p. indicates the development of slightly less than 20 per cent of the recorded water-power resources of Canada.

Growth of Development

Since the inception of long-distance transmission of electricity about the beginning of the present century, water-power development in Canada has had a remarkable growth; the total installation of 143,156 h.p. at January 1, 1900, is insignificant in comparison with that of the 10,312,123 h.p. installed as at January 1, 1947.

On the whole, particularly since 1920, the growth in installed capacity has been very consistent, the average increase per year being, roughly, 290,000 h.p. This growth in installed capacity is largely due to the development of the central electric station industry and improvement in the technique of long-distance transmission which rendered practicable the production of hydro-electric energy at sites remote from the points of utilisation.

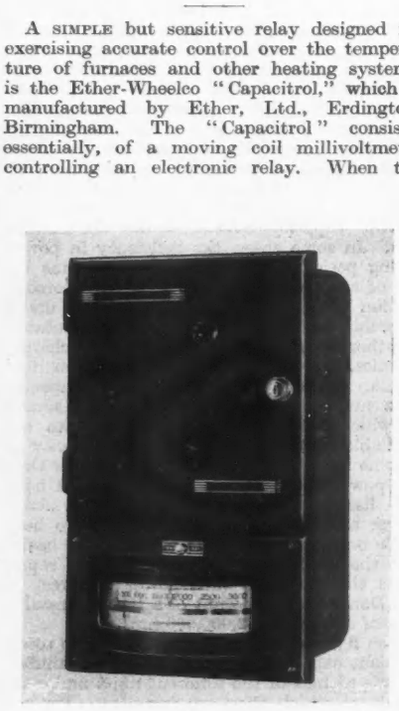
Coal Equivalent

Comparing the water-power development in the Dominion with a corresponding development of fuel power under comparable conditions, indicates that each installed hydraulic horsepower, if operated continuously throughout the year, would be the equivalent of about 4·004 tons of coal, and Canada's present hydraulic installation of 10,312,123 h.p. would be equivalent to the annual use of about 41,000,000 tons of coal. However, each installed hydraulic horsepower does not operate continuously,

due to variations in river flow and power demand. Taking account of the hydro-electricity actually consumed in Canada in 1946, differentiating between electricity used for heating and that used for general power purposes, and making an estimate of the power output of hydro-plants not generating electricity, an actual coal equivalent of more than 22,000,000 tons of coal is indicated.

A Temperature-Control Relay

A SIMPLE but sensitive relay designed for exercising accurate control over the temperature of furnaces and other heating systems, is the Ether-Wheelco "Capacitrol," which is manufactured by Ether, Ltd., Erdington, Birmingham. The "Capacitrol" consists, essentially, of a moving coil millivoltmeter controlling an electronic relay. When the



TEMPERATURE RELAY

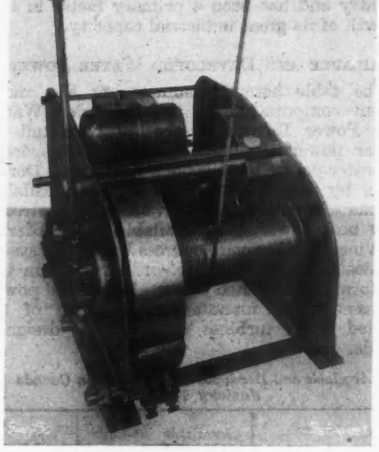
millivoltmeter is connected to a thermo-couple it indicates, in effect, temperature in terms of millivolts. Referring to the accompanying engraving, the upper pointer, which constitutes the setting element, can be set to any desired temperature on the calibrated scale. Behind the scale and attached to the setting pointer are two coaxial coils, which form part of a tuned circuit. The indicating pointer, which is part of the moving coil system, carries a metal flag. This flag is so positioned that, as the indicating pointer approaches the setting pointer the flag passes between the two co-axial coils. Any movement of the flag between the coils alters the frequency of the tuned circuit, de-energises a relay and actuates its contacts. Operation of the relay contacts can be made to control fuel valves or electric heating input in such a way as to keep the temperature of the furnace or heating installation constant at the value determined by the position of the setting pointer.

A Small Friction Hoist

A LIGHT general-purpose hoist, suitable for use with either stationary or portable plant, is now being made by the Vaughan Lift Engineering Company, Ltd., of 47–51, Featherstone Street, London, E.C.1. This hoist, which we illustrate herewith, is designed to raise loads of up to 5 cwt at 120ft per minute directly off the barrel, or 10 cwt at 60ft per minute with a snatch-block hook and two to one roping. For drive either a 3 h.p. Petter air-cooled petrol engine or a 3 h.p. electric motor can be fitted according to requirements.

The frame consists of two steel side plates bolted to heavy base tees and connected by substantial cross members of square section. The engine or motor for driving is mounted on a flat steel bed-plate bolted to the base tees at the rear. A duplex chain drive between the engine and the friction pinion driving shaft incorporates a tensioning gear, which is quickly adjustable from the outside of the side plate. On the high-tensile steel pinion shaft is mounted a cork-faced friction pinion, 4in diameter, with a 5in wide face. This pinion, which rotates at some 330 r.p.m., mates with an 18in diameter combined friction driving and brake drum cast integrally at one end of the rope barrel. Mounted on the cross member at the foot of the front of the hoist is a woven asbestos-lined brake shoe, which has a contact area of 40 square inches on the barrel drum.

A 2¼in diameter shaft, on which the barrel freely rotates, is journaled eccentrically at both ends and gives the barrel a parallel eccentric movement under control of the hand-operating lever. This movement is relatively short and is designed to carry the barrel drum over from the friction brake to the driving pinion. A counterweight on an arm at right angles to the control lever is arranged to maintain the barrel friction drum in contact with the brake. A small movement of the control lever eases the friction drum off the brake to allow the barrel to run freely and lower the load by gravity at a controlled speed. Continuation of this release movement carries the barrel further



PETROL ENGINE DRIVEN HOIST

over and brings the drum into contact with the friction driving pinion when it is required to raise a load. We recently had an opportunity to inspect one of the hoists and found that during both raising and lowering the movement was smooth and that the load was under positive control at all times.

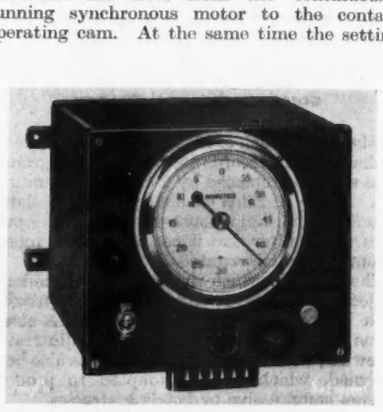
Maintenance on the hoists has been reduced to a minimum by the use of self-lubricating oil-impregnated bronze bearings on all shafts, the bearings on the side plates being carried in substantial hot brass pressings. Adjustments are quickly and easily made and wearing surfaces such as the brake lining are designed for rapid removal and replacement.

If required, the hoist can be arranged for remote control by means of a rope, in which case the control lever is removed and a hand rope is attached to the weight lever. As the engine is kept running continuously to operate the hoist, a remote switch for stopping the engine can be fitted at any required position as a safety measure when a remote control rope is used.

A Process Timer

A SYNCHRONOUSLY-DRIVEN process timer, which is automatically self-resetting, is being manufactured by Londex, Ltd., 207, Anerley Road, London, S.E.20. This instrument, known as the type A S R timer, is designed to control the duration of a variety of industrial processes, particularly those involving repetition work. Typical uses for this process timer include the heat treatment of metals, the curing and treatment of rubber, the control of plastic moulding presses, the timing of chemical processes, and the control of radio frequency heating apparatus.

As illustrated in the accompanying engraving, the process timer is housed compactly in a sheet metal case measuring 7½in by 6½in by 5in. The timing movement is driven by a self-starting synchronous motor of robust construction and the main timing contacts are cam-operated. The desired time interval is preset on the instrument dial. Control of the timing process can be initiated either by a push button fitted to or remote from, the instrument, or by a switch operated by the starting lever or some associated part of the controlled machine. On receiving the starting impulse an electro-magnetic clutch in the timer is energised and transmits the drive from the continuously running synchronous motor to the contact operating cam. At the same time the setting



PROCESS TIMER

pointer is driven back to zero, which marks the end of the timing cycle; from this point the setting pointer returns instantaneously to the preset position ready for the operation to be repeated.

The process timer is made in five standard time scales, ranging from 0–60 seconds, calibrated in ½ second divisions, to 0–12 hours, calibrated in 5 minute divisions. In its standard form the instrument is suitable for operation on a 200–250V, single-phase, 50 cycles supply. For a supply at any other voltage an intermediate transformer can be fitted. The single or double-pole contacts normally fitted are rated at 500VA. For heavier loads the switching capacity can be increased by using a Londex mercury relay, type L Q A, which can be incorporated in the instrument or supplied as a separate unit.

SIR WILLIAM CHAMBERLAIN MEMORIAL SCHOLARSHIP.—The Council of the Institute of Transport invites from persons engaged in or intending to be engaged in road transport within the North-Western Region (defined as the counties of Lancashire, Cheshire, Cumberland, Westmorland), applications for the award in August, 1947, of one Sir William Chamberlain Memorial Scholarship, of value not exceeding £50, and up to seven Sir William Chamberlain Memorial Grants, not exceeding £10 each. The Scholarship may be awarded to assist in meeting expenses to be incurred in travel for the purpose of studying road transport, specific projects of research in or in connection with road transport, full-time study in subjects connected with or ancillary to road transport at a university or other educational institution approved by the Council. Grants may be awarded to assist those needing financial aid to advance their education in road transport, in the purchase of books and instruments, the payment of educational fees, and the payment of travelling or other expenses to be incurred for approved educational purposes connected with road transport. Applications must be made on a form to be obtained from the hon. secretary, Sir William Chamberlain Memorial Advisory Committee, 55, Piccadilly, Manchester, 1. The completed form must be deposited not later than July 14, 1947, with the Institute of Transport, 15, Savoy Street, London, W.C.2.

Floating Caisson for Graving Dock at Le Havre

WHEN the Germans were driven from Le Havre in 1944, they destroyed the port, which has been under reconstruction since June, 1945. In order to destroy the large dry dock No. 7, mines were exploded in the walls and in the entrance caisson, and two ships and a dredger were scuttled in the dock. The extent of the damage to the dock and the obstructions to its entrance caused by sunken vessels will be appreciated from the diagram reproduced in Fig. 3.

As a first step towards repairing the dock, a new floating caisson was built and has now been placed in position. This caisson was built at the Naval Construction Works of Vickers-Armstrongs, Ltd., to which firm we are indebted for the following particulars.

The new caisson is of all-welded construction and consists essentially of a permanent ballast chamber; settling tank; auxiliary water ballast preponderance tanks at each end; an air chamber and pump room, and tidal tanks above the air chamber, which are separated from it by a watertight deck. The caisson is 132ft long, 58ft 10in high, from keel to top deck, 27ft 10in in beam, and has a normal draught of 26ft 6in. Its displacement is 2734 tons.

The greenheart sills and side keels, forming the sealing faces, are faced with matting, made from woven 3½in tarred hemp ropes, secured by clout-nails to the greenheart.

Power and lighting are conveyed to the caisson through a flexible shore cable. The pump room contains two electrically-driven centrifugal pumps, each capable of discharging from the settling tank 100 tons of sea water per hour, against the maximum head. Two electrically-driven capstans are fitted on the top deck, each giving a pull of 5 tons at 40ft per minute. The control house on the top deck contains the switchboard and the controls for the valves operating the flooding and discharge of the settling tank.

Upon arrival at Le Havre, it was found necessary to manœuvre the caisson into position, as shown in Fig. 3. Although direct entry was just possible, it was considered too risky as the action of the wind and tide might have caused a jam between the masonry buttress and the south wall of the dock entrance. At the passage between the wreck of the "Paris" and the masonry buttress, the clearance below water was 10in. In order to manœuvre the caisson into position, two tugs were used in conjunction with a lorry on the South quay, and a capstan on the opposite side of the dock entrance.

After the caisson had been sunk in position at low water on March 17, 1947, the dock was partly pumped out and pumping was stopped after the level had been lowered by 6 m, to allow the damaged walls to drain.

Pumping was re-started on March 18th, and the dock emptied. The seal was found to be excellent and the new caisson has made it possible to deal with the sunken vessels in the dry dock. Repair of the walls is proceeding, preparatory to raising and docking the "Liberté" (ex "Europa"), which broke from her moorings during a gale in December, 1946, and sank in the tidal basin after collision with the wreck of the "Paris."

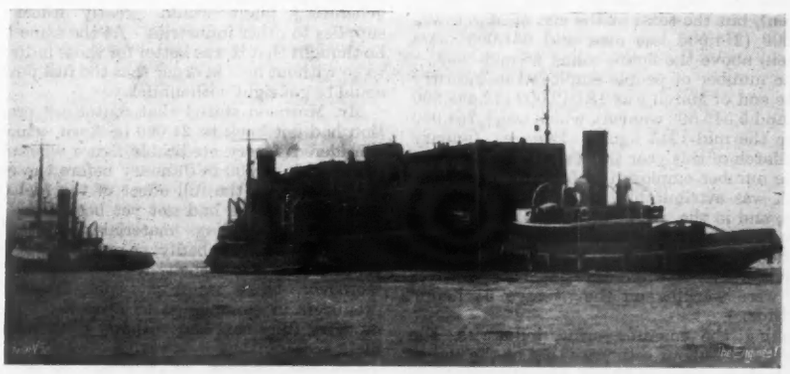


FIG. 4—CAISSON UNDER TOW ACROSS CHANNEL

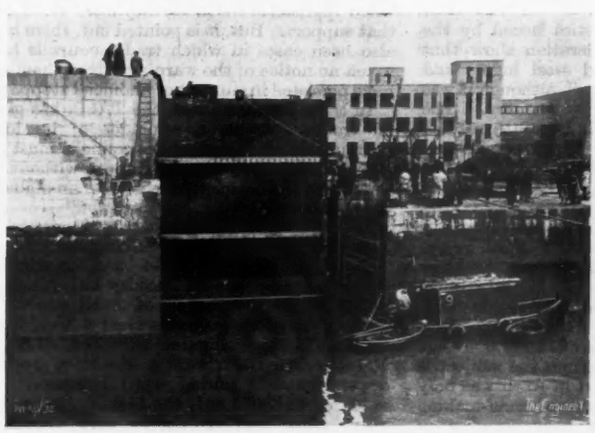


FIG. 1—CAISSON WARPED INTO RECESS OR "OUT" PO ION

FIG. 2—CAISSON PASSING BETWEEN THE "PARIS" AND BUTTRESS

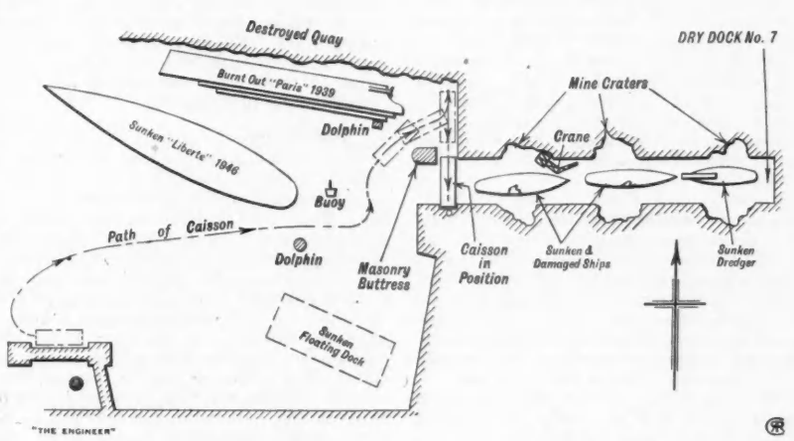


FIG. 3—DAMAGED DOCK AND INSTALLATION OF CAISSON

WATFORD INDUSTRIAL EXHIBITION.—An exhibition illustrating the diversity of the products manufactured in and around Watford is to be held at the Town Hall, Watford, from June 5th to 18th. It will be open each day from 11 a.m. to 9 p.m.

Industrial and Labour Notes

Employment and Unemployment

The latest employment figures issued by the Ministry of Labour show that the total working population of Great Britain at the end of March was 20,200,000. During the months of February and March the working population declined by 64,000 (39,000 men and 25,000 women), but the total at the end of March was 450,000 (211,000 less men and 661,000 more women) above the figure ruling at mid-1939.

The number of people employed in industry at the end of March was 18,043,000 (12,498,000 men and 5,545,000 women), which was 1,754,000 above the mid-1945 figure. Between January and March of this year there was a net decrease in the number employed in industry of 83,000, which was attributable to the fuel and power crisis, and in the week ended March 22nd there were 268,000 operatives on short time losing 16½ hours on the average. On the other hand, in the same week, there were 560,000 operatives who were working on the average 6½ hours' overtime.

Taking the manufacturing industries, the Ministry of Labour estimates that at the end of March there were 5,066,000 people engaged in the production of goods for the home market and 1,468,000 producing goods for export A closer analysis of the figures shows that in the twenty-one months from mid-1945 to the end of March, 1947, the number of people employed in manufacturing for export increased by 1,058,000. In the same period the number employed in manufacture for the home market increased by 2,486,000 and at the end of March was 511,000 greater than at mid-1939.

The latest unemployment figures relate to April 14th, on which day there were 426,989 insured persons registered as unemployed. On March 10th there were 764,848 so registered, a figure which, of course, reflected the effects of fuel restrictions. The unemployment total for January 13th—just prior to the electricity crisis—was 401,249. The April 14th figure of 426,989 unemployed included 49,545 who were temporarily stopped, and 45,861 married women, some of whom are probably retiring from industry. It also included 21,706 ex-Service personnel who had had no employment since leaving the Forces. There were 15,752 uninsured persons on the unemployment registers on April 14th, including 8201 boys and girls under sixteen who had not entered industry.

At a Press conference on Friday last, the Lord President of the Council, Mr. Herbert Morrison, commented on manpower and employment in the United Kingdom, saying that unemployment had dropped back almost to the pre-crisis level after reaching a peak of 2,377,000 in February. The immediate battle now was more against under-employment within industry rather than against unemployment of those for whom industry had no room, except, of course, in the development and other areas, where some were still waiting for the completion of the factory building programme. Our trouble was, Mr. Morrison said, that we were trying to run a much busier and more productive economy than before the war with more workers in jobs, but without enough fuel, raw materials and food to support the effort, and with such low stocks that stoppages and restrictions were inevitable.

Industrial Production

A review of Britain's economic situation was made by the Lord President of the Council, Mr. Herbert Morrison, on Friday last, who said that even now it was much too early to judge accurately the effects of the fuel crisis on industrial production. Output had also been affected recently by the hard winter weather and shortages of raw materials and manpower. Steel production dropped badly during the crisis in February, when it fell back nearly to the 1938 figure, and in March it was slightly lower still, though in April it rose again to 236,000 tons weekly—nearly up to the high 1946 average—which was achieved, however, at the expense of running down stocks of pig iron and scrap. The steel outlook, Mr. Morrison continued, was still a cause for anxiety. The priorities which it had been necessary to give for such steel-using industries as the manufacture of coal mining machinery and electrical generating plant would greatly affect the supplies to other industries. At the same time, he thought that it was better for those industries to go without now in order that the fuel position could be got right without delay.

Mr. Morrison stated that motor-car production had got back to 24,000 in April, which he considered a very creditable figure when compared with 25,000 in January before the crisis. He added that the full effect of the fuel crisis upon components had not yet been seen. The output of building materials, particularly bricks, had suffered badly, as producers of those commodities were such heavy users of fuel. Moreover, there were not enough economic producers in commission to keep the building industry fully supplied without great waste of fuel.

On the subject of overseas trade, Mr. Morrison indicated that the April export figure would be just over £82,500,000, compared with £82,600,000 in March. So far there had not been any bad drop in our exports, but the increase which we should be getting this year had not begun and could not begin until the effects of the fuel shortage were overcome.

Iron and Steel Output

The monthly statistics issued by the British Iron and Steel Federation show that production of pig iron and steel ingots and castings improved during April, although it was below the rate achieved in January. The weekly average output of pig iron in April was 139,200 tons, corresponding to an annual rate of 7,238,000 tons. In March production was at an annual rate of 6,400,000 tons, and in January the annual rate was 7,806,000 tons.

The output of steel ingots and castings averaged 236,400 tons a week in April, representing an annual rate of 12,294,000 tons. The annual production rate fell in March to 10,190,000 tons from the 12,470,000 tons reached during January. A year ago steel output was at an annual rate of 13,111,000 tons.

The Federation's comment on the subject is that the level of steel output in April was only attained by depleting stocks of steel-making materials, and points out that supplies of coking coal must be improved if the level is to be maintained.

Price Stability

In a statement circulated with the annual report of G. and J. Weir, Ltd., the chairman, Lord Weir, stresses the vital importance of price stability. In wartime, he says, production alone was the main task, but in peace we have the much harder problem of production qualified by cost and price. Under to-day's conditions in this country, far too little attention is being paid to the importance of the peacetime yardstick of cost. Pointing out that some of the firm's larger contracts involve a period of over two years before they are completed, Lord Weir says there is no idea what will have to be paid for British coal during that period.

The price of coal, the statement continues, conditions the price of steel, which is the basis of the engineering industry. Since 1939 the prices of British steel have stood out as models of relative price stabilisation, but if the prices of coal and of rail transport are to rise, as seems inevitable, then the price of steel will also rise. Also, almost every branch of British industry is adopting a shortened working week, largely with maintenance of existing remuneration, and, Lord Weir observes, we have still to find the extent to which this will result in increased costs and prices in most industries.

These examples, the statement adds, concern prices which are to a considerable extent within our national control, but there are also the international prices of the non-ferrous metals and timber, which to-day stand at almost famine level. These, Lord Weir points out, may go still higher, but there is little we can do to remedy the matter. Rising costs coupled with material shortages, and a measure of doubt as to the supply of the main fundamentals of industry, in particular coal, power, rail transport and steel, represent, in Lord Weir's view, the greatest dangers which face the engineering industry.

Trades Councils and Unofficial Strikes

Some observations on "the sporadic unofficial strikes which have in recent months done such grave harm to the national economy" are made in the May issue of *Labour*, the official organ of the Trades Union Congress. The journal says that affiliated unions have taken—and are taking—their own measures to deal with those unofficial stoppages which occur within their own territories, and it is to be assumed that responsible trade unionists, whether directly involved or not, will give them all possible help in a difficult task.

A number of unions, however, have reported to the T.U.C. that certain trades councils have given assistance, financially and otherwise, to participants in unofficial disputes. Investigation has shown that in some cases trades councils have acted under the impression that the disputes were officially supported, and that, when apprised of the facts, they have withdrawn that support. But, it is pointed out, there have also been cases in which trades councils have taken no notice of the warnings given them and have persisted in support of unofficial stoppages.

In these circumstances, the T.U.C. has given all trades councils a reminder of its long-standing decision that trades councils must not intervene in any industrial dispute without the consent of the national executive of an affiliated union concerned.

British Overseas Trade

From the Trade and Navigation Accounts published on Tuesday last, it may be seen that in the month of April exports of United Kingdom goods reached a total value of £82,673,925, compared with £82,593,805 in March, when there were a few more working days. Imports during April increased to a value of £147,075,861, the highest figure since July, 1920, and re-exports were valued at £5,700,000.

Allowing for the rise in prices, April exports were equal in volume to 98 per cent of the 1938 average. The volume figure for March was also 98 per cent and for February 92 per cent. A feature of the April figures is the further increase in the value of machinery exports, which represented about one-fifth of the manufactured goods sent overseas from this country. Vehicle exports, which declined during March, made a substantial recovery during April. Exports of textile machinery, however, were slightly lower than in March, although they were considerably above the corresponding 1946 figures.

Coal Output

Coal output figures for the second five-day week in the mines were announced by the Minister of Fuel and Power on Tuesday last. They show that, in the week ended May 17th, production in the United Kingdom of saleable mined coal amounted to 3,847,300 tons, and of opencast coal, 209,500 tons, making a total of 4,056,800 tons. The tonnage of mined coal lost through various causes during the week is estimated at 42,400. Last week's output was therefore above that in the week ended May 10th—3,756,100 tons—when a greater tonnage was lost through disputes in Durham and Lancashire and holidays in Scotland. Total production in the week ended May 18, 1946, was 3,943,600 tons.

French Engineering News

(From our French Correspondent)

PARIS, May 16th

There has been some improvement in supplies of sheet metal. The Distributor of Steel Products has decided to annul 50 per cent of the orders on hand, and, in consequence, delays in delivery should be reduced by about half—that is, to between seven and eleven months. Although delays are still far too long, the move should clear up some of the disorder prevailing. Increased supplies are expected to result from mechanisation now taking place in rolling mills. Industry is using more and more sheet. However, the conditions prevailing are said to be due to watertight partitions between the two responsible organisations at the Ministry of Industrial Production. The organisation controlling consumption wishes to develop exports and is backing the automobile industry in its efforts to increase production to satisfy internal and external demands. The automobile industry has therefore obtained relatively big supplies compared with other industries. It has probably also benefited by the control over the manufacture of sheet exercised by certain automobile plants to obtain supplies over and above the allocation. The organisation controlling production at the Ministry has not failed to notice the supplies made available to automobile constructors. The industry, which has no priority, is always the first to be supplied, while other industries see their allocations retarded. The Distributor for Steel Products has therefore decided that consumption by the automobile industry shall be strictly controlled and allocations will be reduced from one-quarter to one-sixth of production. At the moment steel sheet production has reached its pre-war level. Provided the rolling mills receive more semi-products and power, that level should be exceeded this year. Provisional figures issued for the first quarter of 1947 show that 274,000 tons of sheet were produced, as against 152,000 tons in 1938.

* * *

The plan for the reconstruction of the left bank of the Seine at Rouen includes the building of two new bridges, a wide boulevard and spacious streets. To put it into effect would need major alterations to railway installations in that area. The Rouen-Rive Gauche and the Rouen-Orléans stations are both situated on the left bank of the Seine and serve the quays as well as many sidings. These lines, as well as the junction between the two stations, were severely damaged in 1944. Railway installations will be moved west into an essentially industrial area. The quay will be enlarged, and the viaduct between the two stations will be removed, a road connection being established with a covered way.

* * *

The fall in French exports, mainly to the United States, has been so great as to constitute a threat to the fulfilment of the Monnet Plan. The reason is mainly to be found in the high prices prevailing in France. Although some decrease in internal prices followed the 10 per cent cuts, export prices are not affected. The Monnet Plan had drawn up estimates for the development of French foreign trade for the period 1946–50, given as follows, in millions of dollars :—

Year.	Imports.	Exports.	Balance.
1946	2310	670	−1640
1947	2610	1225	−1385
1948	2490	1600	− 890
1949	2250	2000	− 250
1950	2130	2195	+ 65

In the first year of the plan, 1946, imports were 18 per cent less than forecast due to delays in delivery, but exports exceeded by 26 per cent the figure estimated, so that the deficit was smaller than had been expected. It is a fact, however, that the prospects for 1947 are not so good. The Minister of Finance, Monsieur Robert Schumann, has indicated an increase in imports over the estimated figure and official statistics admit that exports to the United States are slumping, despite an encouraging overall picture.

Notes and Memoranda

Rail and Road

C.P.R. EARNINGS.—Addressing the recent annual general meeting of the Canadian Pacific Railway Company, the president, Mr. W. M. Neal, said that earnings in the three months ended March 31st were 71,348,120 dollars, an increase of 186,827 dollars over the same period of 1946. Revenue from passenger services continued to decline, but freight revenues were greater than in any first quarter previously. The revenues, Mr. Neal explained, had benefited from the general freight rate increase granted by the Interstate Commerce Commission and which the Board of Transport Commissioners for Canada approved for international traffic. This rate increase was computed as averaging 17·6 per cent on all traffic in the U.S.A. and was made effective on January 1st of this year.

COAL WAGONS.—A question addressed recently to the Minister of Transport sought information about the types of the 50,000 16-ton steel railway wagons ordered by his department. It also asked whether, in all future orders of railway wagons for the transportation of coal, the Minister would abandon the old-fashioned hand-unloading flat-bottomed wagons and replace them with bottom-discharge self-trimming hopper-shaped wagons, so as to minimise labour cost and speed delivery. In a written reply, the Minister says that the 50,000 wagons ordered are of the open mineral type, rectangular and flat-bottomed, with one end, two side and two bottom doors, and the specification admits of welded or of riveted construction or a combination of both. It is not practicable, the reply continues, to provide for all coal-carrying wagons to be of the hopper type. Much coal in this country is unloaded in station yards by private merchants direct to road vehicles, and so long as this continues the Minister feels that it will be necessary to retain the present standard type of wagon.

Air and Water

AMERICAN SHIP SALES.—The United States Maritime Commission reports that 1193 surplus American merchant ships were disposed of during the first three months of this year, 831 of them going to overseas purchasers. The overseas sales included 506 " Liberty " ships.

GAS TURBINE FOR LOUVAIN UNIVERSITY.—A Whittle type gas turbine aero-engine in running order is being presented to-day by the National Gas Turbine Establishment and Power Jets (Research and Development), Ltd., to the University of Louvain. The Faculty of the University has agreed that the engine shall be accessible to engineering students of other universities in Belgium.

ROYAL AERONAUTICAL SOCIETY.—The following awards have been made recently by the Council of the Royal Aeronautical Society :—Simms Gold Medal, Professor L. Aitchison ; George Taylor Gold Medal, Professor A. R. Collar ; Wakefield Gold Medal, Mr. Edwin Link ; Society's Silver Medal, Mr. W. G. Carter ; R.38 Memorial Prize, Mr. J. K. Hardy ; and Edward Busk Memorial Prize, Mr. J. Smith.

PROVISIONAL MARITIME CONSULTATIVE COUNCIL.—The first session of the Provisional Maritime Consultative Council was held in Paris last week-end, on the invitation of the French Government. The Council, it may be recalled, was set up as a result of a recommendation by the United Maritime Consultative Council. It is an interim organisation to continue governmental consultation on shipping matters pending the establishment of a permanent body by the United Nations. The meeting provided an opportunity for the exchange of information and for consultation among Governments on shipping problems of an international character.

Miscellanea

INSTITUTION OF MINING ENGINEERS.—The summer meeting of the Institution of Mining Engineers will be held in Edinburgh on Wednesday, Thursday and Friday, June 18th, 19th and 20th. The meeting will begin at 11 a.m. on Wednesday, June 18th, in the Upper Library of the University (Old College), Edinburgh, and after an official welcome, papers will be presented by Dr. W. Reid and Mr. H. R. King on " Planning a New Colliery in 1947," and by Mr. G. Mackay on " Planning the Reorganisation of Whitehill Colliery, Midlothian." Discussion of the papers will be resumed on Wednesday afternoon. On Wednesday evening, at 7.30 p.m. the Lord Provost will hold a reception at the City Chambers, and on Thursday evening, June 19th, the Institution dinner will take place at the North British Station Hotel, at 7 for 7.30 p.m. Excursions for members and their ladies have been arranged for Wednesday afternoon and for the other two days of the meeting.

NEW SELECTED GENERATING STATIONS.—The Central Electricity Board has adopted, without modification, the Mid-East England (Alteration and Extension) Scheme, 1947, which provides for the erection, when they have been authorised, of three new selected generating stations, each with an initial installation up to 130,000kW. It will be recalled that the first of these stations will be located on the Trent in the vicinity of Keadby.

F.B.I. LECTURES ON RESEARCH.—The first of a series of lectures on " The Organisation of Industrial Research," arranged by the Federation of British Industries Industrial Research Committee, is to be delivered in the F.B.I. Council Room, 21, Tothill Street, S.W.1, on June 9th, at 6.15 p.m., by Mr. Robert Price Russell, president of the Standard Oil Development Company of U.S.A. Mr. Russell, who will be visiting this country to deliver the Cadman Memorial Lecture, was awarded the Medal for Merit, the highest U.S. award to a civilian, for outstanding services to the scientific side of the war effort.

THE SIR WALTER PRESTON SCHOLARSHIPS.—The trustees under the Sir Walter Preston scholarship scheme announce that undergraduate and post-graduate scholarships and research fellowships are available in all award groups. Applications for undergraduate scholarships must be forwarded not later than June 7, 1947, and for post-graduate scholarships and research fellowships not later than July 12, 1947. Application forms and full details are obtainable from the secretary, Sir Walter Preston Scholarships and Research Fellowships, care of Textile Machinery Makers, Ltd., 60, Huddersfield Road, Oldham.

INCREASED PETROL PRICES.—Following the increase in the world price of petroleum products in recent weeks, the position in this country has been examined by the Ministry of Fuel and Power in consultation with the Petroleum Board, and the following increases in prices have been approved, as from May 15th :—Motor spirit, increase of 1½d. per gallon, making the ex-pump price in the England and Wales and South Scotland zone 2s. 0½d. per gallon and the wholesale price 1s. 9d. per gallon ; diesel oil for road vehicles, increase of ½d. per gallon ; paraffin, increase of 1d. per gallon ; vaporising oil, increase of 1d. per gallon ; white spirit, increase of 1½d. per gallon ; and bitumen, increase of 9s. per ton.

GENERATION OF ELECTRICITY, APRIL, 1947.—The Official returns rendered to the Electricity Commissioners show that 3387 million units of electricity were generated by authorised undertakers in Great Britain during the month of April, 1947, as compared with the revised figure of 3057 million units in the corresponding month of 1946, representing an increase of 330 million units, or 10·8 per cent. During the first four months of 1947 (*i.e.*, up to the end of April) the total number of units generated by authorised undertakers was 15,722 million units, as compared with the revised figure of 14,482 million units for the corresponding period of 1946, representing an increase of 1240 million units, or 8·6 per cent.

THE ILLUMINATING ENGINEERING SOCIETY.—The first post-war dinner of the Illuminating Engineering Society was held at Grosvenor House, London, on Wednesday evening, May 14th, with Mr. J. S. Dow, the President, in the chair. The toast of " The Illuminating Engineering Society " was proposed by Lord Marley, deputy-chairman of the Parliamentary and Scientific Committee, who stressed the importance of maintaining good standards of lighting throughout industry. He praised the Society for the work that it was accomplishing in this direction, pointing out that, whilst these were days in which economy was necessary, efficient lighting, especially in factories, was a valuable asset to production in that it was essential to the health and well-being of the workers. The President, in his response, also referred to this matter, saying that by diminishing illumination we might make some economy, but we nevertheless had to pay the price. The toast of " The Guests " was ably proposed by Mr. J. G. Holmes. This was acknowledged by Dr. Charles Hill, Secretary of the British Medical Association, whose brilliantly witty speech particularly delighted the large company present.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

"Britain's Best" Engineering and Metalcraft Exhibition

To-day, May 23rd.—London, Royal Horticultural Hall, Westminster, S.W.1.

Chemical Engineering Group

Wednesday, May 28th.—Waldorf Hotel, Aldwych, W.C.2. Annual general meeting and dinner. 5.30 p.m.

Chemical Society

Thursday, June 5th.—Burlington House, Piccadilly, W.1. "Substitution Reactions of Triphenylethylene and Related Compounds: a Contribution to the Problem of Synthetic Analogues of Progesterone," R. Royer and N. P. Buu-Hoi; and "Some Trinuclear Cyanine Dyes: Part I, The Synthesis of Neocyanines," Miss F. M. Hamer, R. J. Rathbone and Miss B. S. Winton. 7.30 p.m.

Institute of Economic Engineering

Sunday, June 8th.—Waldorf Hotel, W.C.2. "Factors Affecting Output per Man-Hour," E. H. Lewis. 2.30 p.m.

Friday, June 13th.—Cowdray Hall, W.1. "Research and Expansion in Industry," R. Cecil Smart. 7 p.m.

Institute of Fuel

Wednesday, May 28th.—Geological Society, Burlington House, Piccadilly, W.1. "Combustion and Combustion Equipment for Aero Gas Turbines," E. A. Watson and J. S. Clarke. 2.30 p.m.

Institute of Welding

Tuesday to Friday, June 3rd to 6th.—North-East Coast meeting, Newcastle-on-Tyne.

Wednesday, June 25th.—Grosvenor House, Park Lane, W.1. Annual dinner. 7.15 p.m.

Institution of Electrical Engineers

Saturday, June 21st.—S. MIDLAND CENTRE.—Visit to Meaford power station. 12.30 p.m.

Institution of Mechanical Engineers

Sunday to Friday, June 8th to 13th.—Centenary celebrations in London (see page 399), May 9th.

Institution of Mining Engineers

Wednesday to Friday, June 18th to 20th.—Summer meeting in Edinburgh.

Institution of Production Engineers

Saturday, May 31st.—YORKSHIRE GRADUATES: Visit to David Brown Tractors, Ltd., Meltham. 2.30 p.m.

Manchester Association of Engineers

Wednesday, June 4th.—Visit to the works of Rylands Brothers, Ltd., Battersby Lane, Warrington. 2 p.m.

Royal Institution of Chartered Surveyors

Monday, June 2nd.—12, Great George Street, S.W.1. Annual general meeting. 5 p.m.

Stephenson Locomotive Society

Saturday, May 24th.—SCOTTISH CENTRE: Visit to North British Locomotive Co., Hyde Park, Glasgow. 2.30 p.m.

Saturday, May 31st.—Visit to Crewe Works and Sheds, L.M.S.R. 9.30 a.m. and 2.30 p.m.—Visit to Eastleigh Running Shed, S.R. 3.30 p.m.

Saturday, June 28th.—Visits to Brighton works, Redhill and Brighton running sheds, Southern Railway.

Women's Engineering Society

Saturday, June 14th.—Visit to the City and Guilds College, Exhibition Road, S.W.7. 2.30 p.m.

INTERNATIONAL SCIENTIFIC FILM CONGRESS.—Following the eighth Congress of Scientific Films, held in Paris in October, 1946, and the subsequent exchange of ideas between the Institut de Cinématographie Scientifique, Paris, and the Scientific Film Association, London, and observers from U.N.E.S.C.O., Czechoslovakia, Poland, Sweden and U.S.A., it was agreed that it was necessary to establish an international scientific film organisation. After preparing a draft constitution, the British and French organisations have been meeting recently in Paris to complete arrangements for an inaugural congress, to which all countries are being invited, to be held in Paris at the beginning of October, 1947. It is hoped that the proposed association will assist in the provision of a number of practical and urgently needed services, especially the freest, widest and most efficient exchange of information about the production, use and effect of all types of scientific films, films themselves and cinematographic material and the personal experience, skill and ideas of workers in this field.

Personal and Business

MR. H. G. WEBSTER has been appointed a director of Armstrong, Stevens and Son, Ltd.

MR. H. C. YOUNG, M.I. Mech. E., has been elected President of the Society of Inventors.

MACROME, Ltd., has now moved into new premises at Aldersley, Wolverhampton (telephone, Tettenhall 52001).

ASSOCIATED BRITISH OIL ENGINES, Ltd., states that the name of Oil Engines (Coventry), Ltd., has been changed to Cub Oil Engines, Ltd.

MR. A. B. DAVIES, Mr. R. F. Stevens and Mr. H. W. Wagner have been appointed directors of the Sturtevant Engineering Company, Ltd.

BRITISH INSULATED CALLENDER'S CABLES, Ltd., announces that the address of its Brighton office has been changed to 59a, Middle Street, Brighton.

MR. C. S. GILL, managing director of Davy United Roll Foundry, Ltd., has been re-elected president of the Teesside Chamber of Commerce.

DR. F. N. WOODWARD has been appointed Director of the United Kingdom Scientific Mission in the British Commonwealth Scientific Office in Washington.

THE LONDON AND NORTH-EASTERN RAILWAY COMPANY announces the retirement of Mr. H. W. Green, M.I.E.E., area electrical engineer, Newcastle-on-Tyne. He entered the service of the North-Eastern Railway in 1897.

TUBE INVESTMENTS, Ltd., announces that Sir Edmund Crane has relinquished, at his own request, all his executive responsibilities, and that Mr. Arthur Chamberlain has been appointed sole managing director of the Hercules Cycle and Motor Company, Ltd.

Launches and Trial Trips

SHERBRO, motor cargo liner; built by Furness Shipbuilding Company, Ltd., for the Elder Dempster Lines, Ltd.; length 385ft, breadth 57ft, depth 32ft 9in; 6000 tons deadweight. Engines, four-cylinder Doxford opposed-piston of 3100 b.h.p. Launch, May 6th.

JUANITA BEAZLEY, coastal oil tanker; built by Harland and Wolff, Ltd., for the Anglo-Ecuadorian Oilfields, Ltd.; length 227ft, breadth 38ft, depth 14ft. Engines, four sets of twelve-cylinder "V" type non-reversing Paxman Ricardo four-cycle diesel. Completed, May 5th.

LEO, cargo steamer; built by Swan, Hunter and Wigham Richardson, Ltd., for the Wilson Line; length 297ft, breadth 42ft, depth 25ft 3in; 2070 tons deadweight. Engines, single-screw, triple-expansion, working in conjunction with a low-pressure exhaust turbine on the Bauer-Wach system; boiler pressure 210 lb. Launch, May 5th.

Catalogues

AVELING-BARFORD, Ltd., Grantham.—Publication No. 1485, covering the new "G" series diesel rollers.

TANGYES, Ltd., Birmingham.—Illustrated brochure on a new Tangye 25-ton universal testing machine.

TODD BROTHERS (ST. HELENS AND WIDNES), Ltd., St. Helens, Lancashire.—Illustrated booklet on chains.

ROBERT JENKINS AND CO., Ltd., Rotherham.—Catalogue giving details of welded work done by the firm.

ASHWORTH AND PARKER, Ltd., Riverside Works, Bury.—Catalogue dealing with the firm's steam engines.

MOND NICKEL COMPANY, Ltd., Grosvenor House, Park Lane, W.1.—Publication on Ni-Hard cast iron alloys.

WEIR HOUSING CORPORATION, Ltd., Calder Street, Coatbridge.—Booklet describing the Weir "Quality" house.

METALLIZING EQUIPMENT COMPANY, 58–60, Victoria Street, S.W.1.—Catalogue describing the metallizing process.

FISHER AND LUDLOW, Ltd., Rolfe Street, Smethwick, Staffs.—Catalogue describing the "Flowline" conveyor system.

CHURCHILL MACHINE TOOL COMPANY, Ltd., Broadheath, Manchester.—Catalogues dealing with grinding machines.

WILLIAM JESSOP AND SONS, Ltd., Brightside Works, Sheffield, 1.—Brochure describing various "Duritas" carbide dies.

RANSOMES AND RAPIER, Ltd., Waterside Works, Ipswich.—Catalogue on the "Rapier" self-priming water pumps.

COVENTRY GAUGE AND TOOL COMPANY, Ltd., Coventry.—Publication No. 33, describing the "Matrix" thread grinder.

DOMINION BRIDGE COMPANY, Ltd., Lachine, Quebec, Canada.—Catalogue giving details of the firm's Scotch dry-back boilers.

Reports on German and Japanese Industry

Limited numbers of copies of the reports of Intelligence Objectives Sub-Committees on German and Japanese Industry listed below can be obtained from H.M. Stationery Office at the prices stated.

No. of report.	Title.	Post free. s.	d.
F.I.A.T.:			
667	Summary Report on German Automotive Engines	2	8
797	The Electrolytic Chlorine Plant in Hoechst-on-Main	5	8
834	Production of Caustic Potash in Mercury Chlorine Cells	1	1
865	Six Papers on Television (all in German, with English prefaces)	6	8
899	Unipolar Ionised Air Apparatus and Application	2	1
EVALUATION REPORTS (post free 3d.)—			
B.I.O.S.:			
E/R 188	Ulrich Gminder, Manufacturers "Flockenbast": Manufacture of Staple Flax		
E/R 199	Mannesmann-Rohrenwerke: Tube Manufacture		
E/R 234	Wagon Fabrik: Ring Springs		
E/R 279	Joseph Vogele A.G.: Concrete Mixing and Laying Machinery		
E/R 299	Kleemans Vereinigte Fabriken: Quarry Plant		
E/R 309	Hereaus Vacuumschmeltz A.G.: Method of Production of "Einschmeltz" an Alloy for Glass Sealing in Flash-Lamp Bulb Manufacture		
E/R 410	Werke Thyssen: Special Type of Locomotive Boiler		
E/R 479	Matthes and Weber (Henkel): Soda Works		
E/R 530	Hoffmann's Starkefabrik A.G.: Starch Manufacture		
B.I.O.S.:			
1070	Details of Machine for Slitting and Winding Plaster: Supplementary to B.I.O.S. 656 on the German Self-Adhesive Plaster and Tape Industry	3	8
1078	German Chilled Iron Roll Industry	2	1
1084	German Aluminium Fabricating Equipment	1	7
1093	Investigation of the Shaker Shovel Loader for the Loading of Rock in Stone Drifts in the Ruhr District of Germany	3	8
1094	The Ruhrchemie-Ruhrgas Process for Catalytic Enrichment of Coal Gas by Methane Synthesis	2	1
1101	Investigation into the German Bone Glue Industry and its By-Products	4	2
1104	Materials for Construction of Meteorological Balloons	1	1
1105	Plastics and Intermediate Chemicals: Interrogation of Dr. Carl Wulff, of I.G. Schkopau	1	7
1106	Report on Visits to Some Mineral Water and Dairy Plant Manufacturers in Germany	5	2
1111	Industrial Ceramics: Interrogation of Dr. Ungewiss, of Steatit-Magnesia A.G., Berlin	0	7
1114	Traversing Gear for Rail Wagons at Auguste Victoria Colliery, Huels	0	7
1115	German Chocolate and Confectionery Machinery, Design and Processing	6	8
1116	Production of Bearing Metals at Braunschweiger Huettenwerk	1	1
1117	The Benzin-Benzol Verband, Bochum and the German Benzole Industry	3	2
1119	Synthetic Rubber: Interrogation of Dr. W. Becker, of the Central Rubber Laboratory, Leverkusen	1	7
1120	German Synthetic Fibres: Wet Processing	1	7
1124	Report on the Cotton Spinning Industry of Germany (British Zone)	3	2
1125	A Survey of the German Narrow Fabrics Industries incorporating the Braces Industry	8	3
1130	Manufacture of Mersolate in Germany: Soap Substitute	2	8
1142	The Wintershall-Schmafeldt Process for the Manufacture of Synthesis Gas at Lutzkendorf	3	8
1157	German Dyestuffs and Intermediates Industry: Dyestuffs and Intermediates at Leverkusen and Uerdingen Factories	6	8
1176	Sound Recording, Reproducing and Other Electro-Acoustic Targets	3	2

B.I.O.S. Information Section, 37, Bryanston Square, W.1., which has at its disposal a considerable volume of information not in a form suitable for general reproduction, is prepared to receive enquiries regarding all problems relating to scientific and technical intelligence on both German and Japanese industry.

A Seven-Day Journal

The Cement Industry and Price Structure

On Friday, May 23rd, the report of the committee set up by the Minister of Works, under the chairmanship of Sir Arthur fforde, to review the financial structure of the cement industry, and to report upon price structure, was published by the Stationery Office as a White Paper. All manufacturers of cement in the United Kingdom are members of the Cement Makers' Federation, the report points out, and although the cement industry is not a monopoly in the sense of being under one financial control, price competition has been wholly eliminated. The Federation regards the fixing of prices as one of its primary functions, along with the allocation of production quotas. Even so, the committee recognises that there are elements of competition between makers. It states that in reference to the capital employed, the industry's profits have not been excessive. In 1938 they were 10½ per cent, in 1943 12 per cent, and in 1945 6½ per cent. The committee states that there is no evidence that the Federation had abused its position. The quality of cement had been improved, and additional outlets for the manufacturers had been continually sought. The committee did not succeed in obtaining first hand evidence in support of certain allegations that the Federation's working had led to the quashing of proposals for the erection of new cement plants. The committee recommends that, when the existing price controls are withdrawn, as competition in prices has been eliminated, the Federation should be prepared to submit its price schedules to an independent body appointed for that purpose. The committee suggests that it is now time for a general review of prices, but it does not forecast what changes, if any, should be made. There is, the committee concludes, nothing in the price structure system, as a system, which, it believes, militates against the achievement of an economically sound and fairly delivered price within the United Kingdom, but equally the system does not contain any automatic guarantee that the objectives of the system will be achieved.

Report of the Royal Scottish Museum

The report by the Director of the Royal Scottish Museum, Dr. Douglas Allan, D.Sc., Ph.D., F.R.S.E., to the Scottish Education Department, covering the year 1946, has now been issued. In the Department of Technology much work has been done in stocktaking and planning, while the engineering workshop has been restaffed and re-equipped by the provision of a universal milling machine, two power drilling machines and a grinding machine, and a precision lathe is promised in the near future. Many valuable models have already been reconditioned, and others are being dealt with. The old machinery hall of the museum has been redesigned as a hall of power, and the hall of mining and metallurgy is being reorganised on similar lines, half the exhibits being devoted to coal-mining and half to metallurgical processes. In metallurgy, prominence is being given to ferrous metals, such as iron and steel and their alloys, and aluminium, copper, lead, tin and zinc are treated more briefly. The hall of shipping is now ready and its collection of models has been recently overhauled. Many inquiries have been received regarding the opening of the Technological Department halls and galleries, and a succession of conducted tours for students and overseas visitors has been arranged. Trainees from the Ministry of Labour and National Service training school were given a regular course of lecture demonstrations. Among the temporary exhibitions held in the main hall, that of December last to celebrate the centenary of Elias Howe's invention of the first practical lock-stitch sewing machine may be mentioned. That exhibition was greatly helped by the loan of modern sewing machines by the Singer Sewing Machine Company, which brought the subject up to date. Interesting donations received during the period under review included a set of industrial iron ores from overseas by the Gartsherrie Ironworks, Coatbridge; a pair of hand-scraped hexagonal surface plates by Joseph Whitworth and Co.; and a model of a Short "Sunderland" flying boat, as constructed by Blackburn Aircraft, Ltd., for Coastal Command.

Engineering Industry Export Activities

With a view to obtaining information for its export drive activities, the Engineering Industries' Association, of 9, Seymour Street, London, W.1, recently sent out a questionnaire to each of its 3000 member firms, including small, medium and very large engineering concerns, to find out the present position of the engineering industry with regard to export trade. A summary of the replies received has yielded the following figures and percentages :—81 per cent of the firms are engaged in the export trade, and all save 22 per cent of those firms wish to expand their overseas trade. Of the remaining 19 per cent of the firms not already engaged in export trade, 2 per cent were not in the least interested in overseas trade possibilities; 82 per cent of the firms now exporting wish to extend that trade, while the other 18 per cent cannot and will not export more. Of these, 4 per cent stated that owing to overflowing order books they cannot accept any more export orders. Only half of these 4 per cent added shortage of material as an additional reason for not wanting more export orders. In every case steel was the desired requirement. Now this valuable information has been received and tabulated, all overseas inquiries received by the Association can be forwarded direct and speedily to the firms interested in the type of production needed, and the territories from which the inquiries come thus covered. A statement by Captain C. A. Kershaw, the General Secretary of the Association, points out that the figures mentioned above clearly show that the British engineering industry is playing a valuable part in the job of putting the country back firmly on its feet. On its part the Association is doing all it can in helping the industry to reach the export target set by the Government, and it is making a practice of meeting all overseas buyers arriving here and supplying them with lists of the firms which they can contact.

Provisional Maritime Consultative Council

The Provisional Maritime Consultative Council met in Paris on May 16, 1947, and held a series of meetings which terminated on Friday, May 23rd. Delegates from eighteen nations attended. The meetings were opened by Monsieur Jules Moch, the French Minister of Public Works and Transport, and Monsieur Anduze-Faris, the Secretary-General of the Minister of Public Works and Transport, was designated Chairman. The delegates had before them a resolution adopted by the Economic and Social Council of the United Nations in March, 1947, relating to the necessity for co-ordinating activities in the fields of aviation, shipping and telecommunications in regard to safety at sea and in the air. After full discussion of the problem, it was decided to appoint three expert representatives to meet representatives of the International Civil Aviation Organisation, the International Telecommunication Union and the International Meteorological Office to study the many aspects of this problem and to suggest the procedure by which full co-ordination can best be achieved. The Council called attention to the number of matters in which such co-ordination at an early stage was desirable. For example, in radar and in radio aids to navigation it is most necessary that all the interests concerned are taken into account in the planning, introduction and development of new systems. The Council also discussed questions relating to discrimination and restrictive shipping practices, and the desirability of uniformity in the preparation of statistical information relating to merchant shipping, and reviewed the progress made in the restoration of normal processes of international shipping business. The United Kingdom Government has been requested to undertake the secretarial duties of the Council and to make such arrangements as may prove necessary for the calling of the next meeting of the Council.

Bankside Power Station

There was a further debate in the House of Commons on Friday, May 23rd, regarding the proposed new Bankside power station. At the close of a long discussion, in the course of which there was much criticism of the scheme, Mr. Silkin, the Minister of Town and Country Planning, stated that having considered the whole matter in the light of discussions in the House of Lords and in public, the Government felt obliged to adhere to its decision, and he proposed to give consent to the erection of the power station, subject to the conditions he had laid down. During the discussion one of the speakers made reference to the effect of sulphurous fumes on building stones, and instanced the Palace of Westminster, which, he said, had cost more to repair and restore than it had cost originally. We did not want the same trouble at St. Paul's arising from the new power stations scheme. With regard to the effect of sulphurous fumes, Mr. Silkin gave an assurance that he would satisfy himself on that point before the scheme went forward. On the utilitarian side of the question, the Minister said that up to 1951 we should require an increase of 67 per cent of the existing output of electricity, and between 1951 and 1960 we should have to double our output. The number of alternative sites in the vicinity of Bankside was strictly limited, and a large number of additional sites would be needed in the next few years. If the Bankside power station was not built, London would, he said, be short of 240,000kW of electrical output.

The Institute of Metals

The May general meeting of the Institute of Metals took place at the Institution of Civil Engineers, Great George Street, Westminster, on Thursday, May 22nd, under the chairmanship of the President, Colonel P. G. J. Gueterbock, C.B., M.A. He announced that the Council had decided, in view of the increased work and activities of the Institute, to revert to the practice of having a secretary of its own, instead of a joint secretary with the Iron and Steel Institute. That meant, Colonel Gueterbock said, the loss by the Institute of the personal services of Mr. K. Headlam-Morley, who had done so much for the Institute, particularly during the term of his joint secretaryship in increasing the close liaison and co-operation between the two Institutes. Although there would be separate secretaries in the future, he was happy to say that that close co-operation would continue. He gave grateful thanks to Mr. Headlam-Morley for the work he had done. With regard to the new secretary, he said that the Council had decided unanimously to appoint Colonel S. C. Guillan, who, since his return from war service, had been assistant secretary and editor. He will formally take over his new duties on Tuesday, July 1st, next. Colonel Guillan, the President said, had great administrative ability and a wide knowledge of the requirements of the Institute's publications. He would, he said, carry out the social side of the secretary's duties, which was most important, effectively, and would be approachable by the junior members. He felt that in Colonel Guillan the Institute would have, not only a good servant, but a good friend. The Institute is arranging an autumn meeting, which will take place in Glasgow from Tuesday, September 23rd, to Friday, September 26th.

Sazillism : Its Origin and Evolution

By S. LELIAVSKY BEY

No. V—(*Continued from page 441, May 23rd*)

9.—Corner Stress Concentrations as a Safety Criterion

THE chief discovery of the mathematicians of the post-Levy period was the concentrations of theoretical stresses near the re-entrant angles at the heel and toe of the dam. Why is it, then that so little account of these concentrations has so far been taken by practising engineers ?

At the time when stresses of this type were first pointed out (experiments of Ottley and Brightmore, Minutes of Proc. I.C.E., Vol. CLXXII, 1908, p. 103), a suggestion was put forward that they might eventually be taken up by steel reinforcing bars embedded in the foundation of the dam near its heel. This solution has, however, not been accepted by the profession.

It may be significant in this connection that in presenting the results of his calculations, the author of one of the latest and most advanced investigations (1935, Mr. Brahtz's paper, quoted earlier), in which particular attention is devoted to the analysis of stress concentrations at the re-entrant angles at the heel and toe of the dam, says : " It should be emphasised that even if the gravity dam is used for illustrative examples of application, the aim is not to advance new design criteria . . ." This might appear to be rather a surprising statement, for the stresses calculated in this paper are about twice as great as those of Levy at the toe of the dam, and are less than those of Levy at the heel. How is it, then, possible that the author of the paper does not consider his results as a criterion for design ?

The reply to that question might perhaps be contained in the following abstract from the same publication : " It will be seen that all stresses are compressive and tend to become infinite at the heel and toe. Of course, this is not possible because the material will become plastic before such magnitudes are reached and redistributions will occur near the corners, which must be considered as singular points where the elastic assumptions do not hold. The redistribution cannot be computed by the elastic theory, but it is evident that, after the plastic flow takes place, the stresses will be decreased near the corner and slightly increased a short distance from the corner. It will be noticed that the theoretical stresses are extremely high over only a minute distance, so that the actual forces involved are very small. The effect of redistribution, therefore, can only be slight."

This rather illuminating paragraph is of much value to the practising engineer in assessing the true value of the latest theoretical achievements of the elastic dam theory. The use of the term " theoretical stress " deserves particular mention as rather significant, as well as the fact that such stresses are said to attain high values over minute distances only ; so that a slight redistribution suffices to average them out, bringing down their intensity to the same order of magnitude as in calculations carried out according to the usual methods (described by Mr. Brahtz as " engineering methods ").

We might add that this does not refer to dams alone but applies to many other structural types as well. In fact, were there not such redistribution, very few engineering works could remain standing. To take the most frequent example, consider the case of the common type of plate girder forming nowadays an almost indispensable structural detail of every important engineering or other work. Pure elastic analysis and the photo-elastic method concur in showing that the theoretical stress intensities in the metal close to the rivet holes may largely exceed their calculated values, rising beyond the elastic limit or even the breaking point of the steel—see Fig. 14(*a*). This fact is, however, entirely neglected by designers who use in calculating such beams very simple formulæ, which, at the best, can only furnish approximate average stresses. The reason is that as soon as the elastic limit is exceeded, the resistance rapidly drops—see point *x* in Fig. 14(*b*)—and the plastic flow of the material equalises the stresses. It is obvious that on the removal of the loading, the over-stressed pockets are subject to certain permanent stresses, similar in a sense to those occurring in pre-stressed beams ; but practice shows that they do not affect either the resistance or the stability of the work. The same would naturally apply to the stress analysis and safety of a gravity dam.

An ordinary gearwheel might also be suggested as another striking analogy : suppose, for instance, that the wheel is provided with sixteen teeth. In that case the theoretical elastic stress rises to infinity at thirty-two points. This, however, does not seem to create either undue fears or excessive apprehension among the designers and builders of machines. The similarity of the state of stress in such a wheel and in a dam will be made more evident by inspecting Fig. 14(*c*) and Fig. 14(*d*), which represent, respectively, the stress distribution in a tooth of a gearwheel according to Coker and Filon, and the boundary stresses in the Morris dam according to Brahtz.

These considerations place emphasis on the contention that the abnormally high theoretical stresses shown by the elastic method for points and re-entrant angles should not affect the age-old standards for practical dam design based upon Sazilly's principle ; though, naturally, such stresses may eventually be extremely useful in obtaining a deeper insight into various problems relating to the subject.

Historically speaking, it is not the first time that mathematical research, in reflecting on the practical design of dams, has caused the adoption of heavier sections. Such a change has already occurred on two occasions : first, with Levy's criterion for uplift, and then again with Atcherley's and Pearson's theory for vertical sections, but in both cases the effect was only temporary, and the old standards gradually re-established themselves after the crises had subsided.

There are, therefore, sufficient reasons to believe that Sazilly's method will continue to be used as the main basis for dam theory, although additional stresses (due to three-dimensional effects, volumetric changes and foundation settlements) may have to be provided for by the introduction of extra margins of safety when the present standards of height are gradually exceeded.

The corner stress concentration problem may, of course, be approached from another angle also ; in fact, these concentrations may eventually be considered as another type of secondary effect and thus covered by a specific margin of safety, to be introduced into Sazilly's basic solution over and above all other safety factors.

Proposals to that effect have, indeed, been made in the press. It has been, for instance, suggested that in order to ensure safety against corner stresses it may be

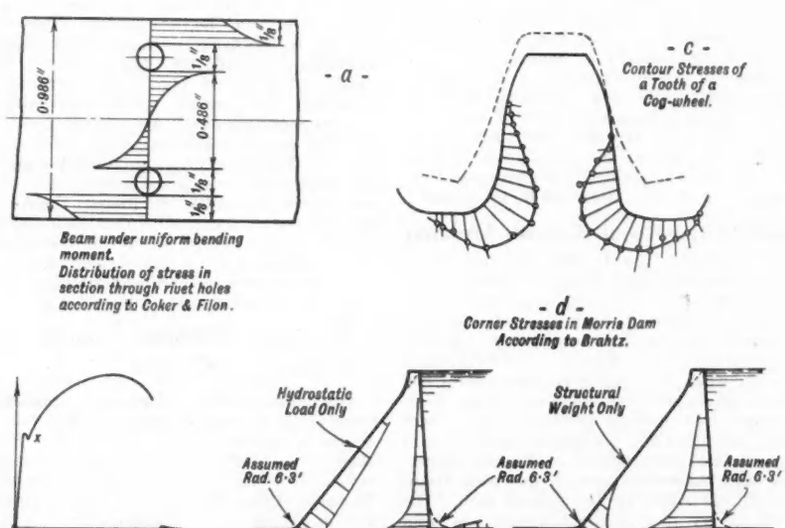


FIG. 14—ILLUSTRATIONS OF STRESS CONCENTRATIONS AT HOLES AND CORNERS

advisable to return to Levy's "uplift" criterion; that is to say, increase the base-width of the dam to 0·85 of its height.[26]

This compromise is, however, subject to certain very serious objections, for the term "secondary stress" is usually employed in connection with a very real physical phenomenon, which is dependent on a definite primary mechanical cause, such as thermal expansion, foundation settlement, beam action, &c. In every one of these cases the designer is fully aware of the practical circumstances which create or aggravate the secondary effect; for instance, the heat productivity of the cement, the bulk of the load imposed on the foundation, the horizontal restraint versus the cantilever action, &c. He is, therefore, quite capable of selecting, either from personal experience or through comparison with other existing dams or by specific calculations (*e.g.*, the trial-load method), such a value of the additional safety factor which in his judgment suits the particular case in hand; the extra margin being thus translated into terms of additional width, or greater unit rates for the materials used, or better geology of site, and so on.

The conditions with corner stress concentrations are, however, quite different, for we deal here with theoretical values of a somewhat transcendental nature. The fact is that, theoretically, these corner stresses as well as some of the Airy functions from which they are deduced rise to infinite values in the apices of the re-entrant angles and as thousands of dams with such angles have been built and are perfectly safe, the mathematician is somewhat embarrassed in attempting to explain away this obvious contradiction, aiming, as he does, at crowning the exquisite refinement of his abstract analysis with a logically acceptable numerical result.

Various conventional assumptions have actually been employed in these somewhat pathetic efforts. They usually consist in replacing the true shape of the profile of the dam by an imaginary figure, in which curves or polygons are substituted for the sharp corners of the prototype. For instance, in Richardson's calculations the angle was bevelled out, whereas circles (= 0·001) were assumed to be cut around the foot and toe of the profile in the calculation of Jonson.

The arbitrary character of these assumptions is evident. The theoretical concentration stress obtained in that manner will be more dependent on the choice of the conventional figure than on the width and height of the actual profile; in fact, doubling the width might affect the theoretical corner stress to a lesser degree than increasing the imaginary radius by a few inches. Adding, therefore, extra material to the dam in order to balance the effect on such imaginary radii would seem to be scarcely a practical proposition.

A less arbitrary method is suggested by Brahtz; here is what he says on the subject: ". . . in order to be able to predict the elastic stresses at the heel and toe it would be necessary to fillet the corner with a large enough curvature to keep the theoretical stresses within the elastic limit at all times. This was done in other studies of this dam (Grand Coulee dam)." The artifice consists, therefore, in the following: we must start by fixing the maximum stress intensity in such a way as not to exceed the elastic limit, and then, find the corresponding imaginary radius and carry out the calculation accordingly.

The academical perfection of the method is beyond any doubt; it is, however, somewhat difficult to see the practical advantage of a calculation the most important and significant result of which must be fixed in advance before it can be carried out. It is true that the author of the investigation has himself explicitly stated that it was not intended to be used as a criterion for dam design; the frankness of the admission was, however, somewhat marred by the following paragraph which appeared a few pages later in the same publication. "The approximate method of analysis is recommended only for preliminary work in order to fix suitable dimensions in the base region of the section. In the final analysis one of the methods explained in Application III should be used." This text seems to imply that, after all, Mr. Brahtz presented his method as a new basis of and criterion for design.

Owing to the psychological effect that frequent references to high corner concentrations are apt to produce among wide circles of practising dam designers and the importance of the interests involved, the author ventures to wonder whether the appointment of an authoritative commission or enquiry board would not be timely in order to produce and properly interpret direct material evidence (in contradistinction to the circumstantial evidence so far supplied) in connection with the corner stress concentrations in dams and their practical value as a factor affecting design data.

Comparative life-size models built of true materials with and without fillets and tested to destruction would be essential, which, of course, is a matter of cost. Such expenditure would, nevertheless, be relatively insignificant if the commission could either appease all the fears in regard to corner concentrations or standardise the use of practically effective corner radii, not as an abstract assumption, but as a practical detail to be incorporated into the design of dam profiles.

[26] Cf. "Jorgensen on Stress Functions . . .," "Trans." Am. S.C.E., 101, p. 1285. Attention in this connection might be called to a rather frequent *lapsus*, pertaining to the correct interpretation of the terms "Levy's criterion" and "Levy's method." In fact, it has repeatedly been said that Levy's uplift criterion had been introduced into the French Official Circular of 1897, and that it was thus imposed "manu militaire" upon the designers in this country in the earlier part of the century. This is not correct. The uplift provision incorporated in this circular consisted in reducing conventionally the assumed structural weight of the dam, in the proportion of 100 kg per 1 cubic metre of material. This rather timid stipulation was, of course, quite different from Levy's radical principle. The origin of the confusion lies, very probably, in the fact that the same circular contains another reference to Levy; namely, it prescribes the analysis of oblique joints according to his method. Curiously enough, the error does not occur among foreign writers, but is shared by some French authors as well.

The British Industries Fair

No. V—(*Continued from page 444, May 23rd*)

IN the following article we conclude our description of some of the exhibits shown at the Castle Bromwich, Birmingham, and Olympia, London, sections of the Fair.

Cinema Television, Ltd.

The apparatus displayed by Cinema Television, Ltd., Worsley Bridge Road, Lower Sydenham, London, S.E.26, typified this firm's achievements in applying electronic principles to industrial measurements and process control. One of the many interesting exhibits was a six-channel electronic recorder, which has been designed, in conjunction with the Royal Aircraft Establishment, Farnborough, for the photographic recording of strain and vibration measurements on aircraft.

Essentially, the recorder consists of six separate cathode ray oscillographs and their associated amplifiers, timing circuits and calibration equipment, together with the necessary power supplies. The oscillograph tubes are mounted in close juxtaposition so that the six traces can easily be photographed simultaneously. Provision is made for the rapid connection to the recording oscillographs of inputs from any six out of a large number of strain and vibration gauges.

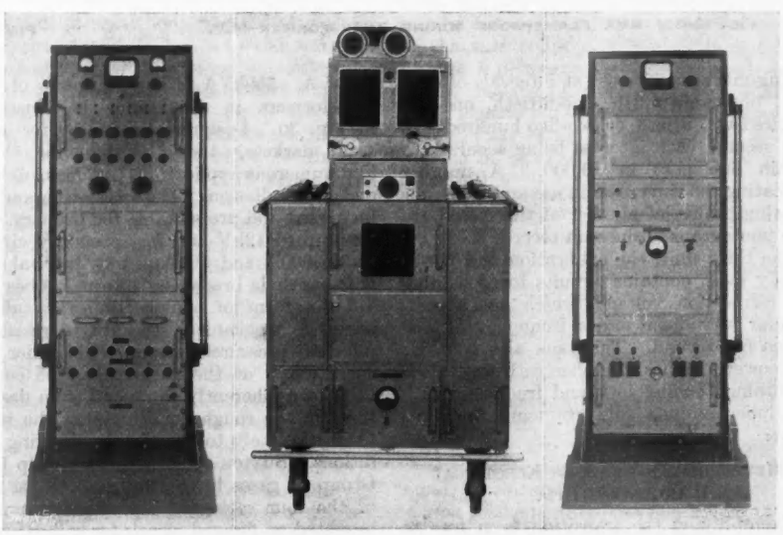


FIG. 29—SIX-CHANNEL STRAIN AND VIBRATION RECORDER—CINEMA TELEVISION

As shown in Fig. 29, the recorder is arranged in three separate units—the input switching rack shown on the left, the amplifier

and camera in the centre, and the calibration and power supply rack on the right. The input switching rack accommodates forty-eight inputs from resistance strain gauges and forty-eight inputs from generator type vibration gauges. The bridge circuits associated with the strain gauges are provided with individual adjustments, so that the whole equipment can be set up before commencing a trial. By suitable switching operations any group of readings up to six simultaneously, can be taken. An interconnection panel allows the inputs to be connected in groups for simultaneous recording.

The camera unit contains the oscillograph tubes with their power supplies, the recording amplifiers and the camera itself, which is designed for use either at low or medium speeds as a continuous strip camera or at high paper speeds as a drum camera. Provision is made for daylight loading of the camera. A gear-box allows the paper speed to be varied over the wide range of ½in to 1000in per second, to suit individual requirements. The camera is provided with a time-trace lamp and optical system designed to record a series of timing marks across the width of the paper simultaneously with the record of the oscillograph traces. These timing marks can be set at intervals of one-fifth, one-twenty-fifth, one-fiftieth, one-two hundred and fiftieth, or one-five hundredth of of a second, each interval being accurate to within one part in 10,000. A number indicating the time scale in use and a counter showing the serial number of the record are also photographed on each record.

The third unit, the calibration and power supply rack, contains circuits for providing the calibration voltage, which has a rectangular wave form and a frequency of 500 cycles per second. This rack also contains the power supplies, together with the valve-maintained tuning fork and frequency sub-multiplier circuits for producing the time trace.

Metropolitan-Vickers Electrical Company, Ltd.

Exemplifying the transition from war to peace, the exhibits displayed by Metropolitan-Vickers Electrical Company, Ltd., Trafford Park, Manchester, were arranged to show how the firm has succeeded in finding peacetime counterparts for wartime developments. One of the outstanding examples of this process of beating swords into ploughshares is the "Seascan" marine radar equipment, which occupied a prominent position on the M.V. stand. This navigational aid is designed for service under severe conditions and consists of five units—console, scanner, transmitter, motor generator and control panel.

Another exhibit concerned the "Ripplay" system for centralised control, which, after being used in wartime for such duties as the control of air raid sirens, is now being re-applied to its original purpose of controlling street lighting and other loads on electricity supply systems. In its improved form the "Ripplay" system allocates a single audio-frequency to each network. Discrimination by sensitive vibrating reed relays is obtained through a system of low-frequency pulsing that gives twelve switching channels. An advantage of the single audio-frequency is that the associated injection plant is considerably simplified and the capital cost is reduced, while the system becomes immune from interference caused by spill-over from adjacent and interconnected networks.

On the heavy engineering side an interesting exhibit was a 200-kVA flameproof mining transformer, representing one of a range of similar equipments covering ratings of 75kVA, 100kVA, 200kVA, 300kVA. The largest of the transformers in this range is illustrated in Fig. 30. Designed originally for overseas markets, these equipments should find numerous applications in mines, oil fields and oil installations. The transformers are oil-immersed and are suitable for primary voltages up to 12kV and for secondary circuits up to 600V and 500A. A cylindrical tank with its ends braced by internal tubes provides a form of construction that affords adequate mechanical strength to resist the internal pressures encountered under test conditions; at the same time, the cooling tubes are inherently protected from damage through the rough handling that the transformer is likely to meet under working conditions. Buxton certificates for Group I and Group II gases have been granted for each of the four ratings. The transformers are mounted on flanged wheels for rail gauges of 20in to 26in; the ground clearance can be set at 1in or 5in as required, and the complete equipment can be slung vertically into or out of position.

Fig. 30—300-kVA Flameproof Mining Transformer—M.V.

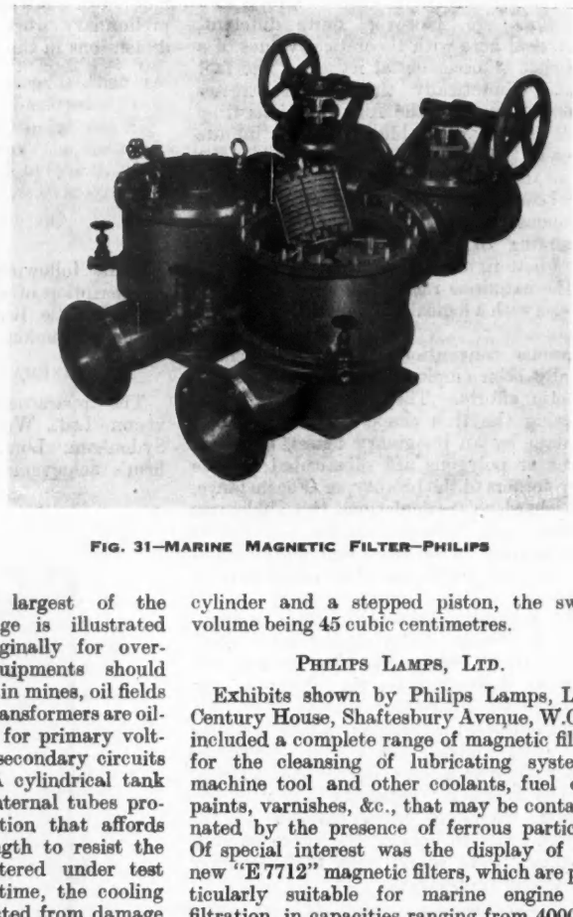


Fig. 31—Marine Magnetic Filter—Philips

Pumps and Compressors

Pumps for process work in oil refineries, including a double-entry, single-stage pump in stainless steel, were exhibited by Sigmund Pumps, Ltd., of Team Valley, Gateshead. Other pumps shown by the firm were a non-clogging type, suitable for paper mills and food production requirements, and large-capacity low-lift pumps for flood and irrigation purposes.

B. and P. Swift, Ltd., North Circular Road, London, N.W.10, had on view a simple high-pressure, rotary gear pump, designed to operate at pressures from 2000 lb to 3500 lb per square inch, for supplying hydraulic power.

Another firm which exhibited a range of hydraulic pumps particularly suitable for operating the mechanisms of machine tools was John Venning and Co., Ltd., of Alton, Hants.

Compressors and a comprehensive range of pneumatic equipment of the light and small-capacity types used on aircraft were on view on the stand of the Hymatic Engineering Company, Ltd., of Redditch. The compressor weighs 5 lb and may be run in either direction at speeds up to 2100 r.p.m. Compression is by two stages, with a single cylinder and a stepped piston, the swept volume being 45 cubic centimetres.

Philips Lamps, Ltd.

Exhibits shown by Philips Lamps, Ltd., Century House, Shaftesbury Avenue, W.C.2,, included a complete range of magnetic filters for the cleansing of lubricating systems, machine tool and other coolants, fuel oils, paints, varnishes, &c., that may be contaminated by the presence of ferrous particles. Of special interest was the display of the new "E 7712" magnetic filters, which are particularly suitable for marine engine oil filtration, in capacities ranging from 4000 to 45,000 gallons per hour.

The particular filter exhibited is capable of filtering 8000 to 12,000 gallons of oil per hour, and is fitted with regulator cocks. As shown in Fig. 31, the equipment consists of two banks in parallel, each containing three magnetic filter units. An important requirement is that cleaning should be possible without interrupting the oil flow, which is readily satisfied in the twin-bank arrangement, by closing the appropriate worm-operated cock on the suction side of the plant, so that the oil is diverted from the bank that requires cleaning. Drain cocks are fitted to the chambers and it is a simple

matter to open the bank, take out the filter units and remove the cages for cleaning. The filter unit which forms the basis of the equipment consists, essentially, of a permanent magnet core surrounded by a filter cage, as indicated in Fig. 31.

Evidently the capacity of the equipment, measured in filtered gallons of oil per hour, depends upon the number of basic units contained in the filtration plant. It is emphasised that the Philips marine magnetic filter is designed to be used as an auxiliary to, rather than as a substitute for, other kinds of filter. Ordinary mechanical filters, when fitted in the main oil-line may be capable of extracting particles down to 0·008in or 0·005in from very light oils. The Philips filter, on the other hand, is designed to extract particles as small as 0·00004in.

A portable, self-contained resistance welding gun was also exhibited. Servo pneumatic control of time and welding speed makes the welding gun capable of carrying out 10 to 120 spot welds per minute. This equipment is rated at 20 kVA, and has a welding capacity of 2 by 16 s.w.g. in mild steel, which is suitable for light gauge assemblies. For heavier work, the welding gun is manufactured in ratings of 40 kVA and 60 kVA.

Electric Construction Company, Ltd.

A car battery charger suitable for operation on a 200–250V, single-phase, 50-cycle supply, and designed to give an output of 2A at 6V or 12V, was shown by the Electric Construction Company, Ltd., Wolverhampton. It is housed in a substantial cast iron case, measuring 4in wide by 4½in deep by 10½in high, suitable for wall or floor mounting. The charger consists essentially of a double-wound transformer with its secondary winding connected to a liberally rated selenium rectifier unit. A 2in dial moving iron ammeter suitably scaled 0–3A indicates the amount of charge. Should the battery be badly run down, charging will commence at 2A, falling ultimately to about 1A when the cells are fully charged. Safe charging without overgassing is ensured by the inherent automatic taper charge characteristic of the rectifier unit. Terminals, clearly marked and coloured, are fitted on each side of the casing for connection to the positive and negative terminals of the battery. On the front of the casing, above the ammeter, is a change-over switch for 6V and 12V batteries.

The firm's "Varispeed" drive was demonstrated in another exhibit, which consisted of a 5 b.h.p. d.c. motor running at 0–2000 r.p.m. when taking its supply from a grid-controlled mercury arc rectifier. The principle of operation was described in The Engineer, November 8, 1946, page 423. The rectifier complete with its transformer, suitable for a three-phase, 400V, 50 cycles supply, is controlled by grids to feed 0–250V on the armature of the motor. Constant excitation of the motor field is obtained by connecting the field windings to the excitation circuit of the rectifier. Speed variation is therefore obtained by variation of armature voltage and can be arranged either for hand or automatic operation.

British Rototherm Company, Ltd.

On the stand of the British Rototherm Company, Ltd., Merton Abbey, London, S.W.19, was to be seen a representative range of thermometers of various types made by the firm for all branches of industry.

A particularly useful new instrument now being made is a dial type pocket thermometer, which has been designed for the personal use of engineers and chemists. This little instrument has a head and stem of stainless material and an easily read dial with permanent scale markings. When the instrument is not in use the stem is screwed into a protective ebonite sheath fitted with a pocket clip. This sheath, as is shown in the photograph we reproduce on Fig. 32, can be used as a holder when making tests by screwing the stem of the thermometer through a cross-hole at the end.

The instrument can be easily carried in a vest pocket, as the thermometer head is just under 1in diameter and with the protective sheath on is about 3¾in long overall. These thermometers are made in three ranges, 0–200 deg. Fah., 0–300 deg. Fah., and 0–150 deg. Cent.

The firm was also showing its "Rotostat" safety controller designed for giving audible indication of unusual rise in temperature in bearings, &c.

Fig. 32—Pocket Thermometer—Rototherm

The principle on which the instrument operates is the same as that governing the firm's well-known temperature gauges. It consists of a metal body and metal stem of any desired length from 3in to 12in. At the bottom of the stem is a bi-metallic multiple-helical coil or element. This element expands or contracts in relation to the temperature change and its movement rotates a light wire shaft, on to the top of which is directly mounted a contact arm. This arm moves over a dial until it reaches a predetermined temperature, whereupon it makes contact with a fixed contact to complete the control circuit, which can either directly operate a bell, or in conjunction with a relay operate a hooter or other apparatus. The instrument is made to cover several ranges of temperature.

General Electric Company, Ltd.

Various applications of electronics in communications, industry and entertainment formed the main theme of the exhibits shown by the General Electric Company, Ltd., Magnet House, Kingsway, London.

On the communications side the display included a thirteen-valve superheterodyne receiver covering a wide frequency range with high sensitivity and general performance under temperate or tropical conditions. The controls include adjustment of crystal frequency, i.f. and l.f. gain, crystal phasing, band width and noise suppression. Two pieces of v.h.f. equipment were of particular interest: the frequency modulated 100W transmitter-receiver, as installed on the Royal and pilot trains for the South African tour; and a car fitted with frequency modulated equipment of the kind supplied to police and other services in this country and overseas. Included in a varied selection of valves was the "C.A.T." 21, a 20kW anode dissipation water-cooled valve employing "metal header" technique and suitable for operation at frequencies up to 100Mc/s. Although this valve was designed primarily for television and f.m. transmission, it is suitable also for h.f. heating in the higher frequency range.

In the industrial field the exhibits included a 5kW high-frequency generator demonstrated in two common *rôles*: first, in dielectric heating, using a new design of oven suitable for preheating plastic flake or powder; secondly, in eddy current heating, using a new tool-tipping equipment. Generators similar to the 5kW unit demonstrated are also marketed by the same firm in two other sizes, rated at 1kW and 25kW respectively.

Another section of the firm's display was devoted to aeronautical applications of electricity and the equipment shown in this category included a 2kW runway flood installation; aircraft galley equipment as used by a number of air lines; and an aircraft telephone exchange as installed in the "Viking" aircraft of the King's Flight.

Bronx Engineering Company, Ltd.

A 25-ton press brake which was shown upon the stand of the Bronx Engineering Company, Ltd., Lye, near Stourbridge, is of all-steel fabricated construction.

The single plates which form the side columns are positioned at the top by a crown of box section and at the bottom by the lower beam of 2in thick plate. The width between the columns is 5ft 4in, whilst the length over the beams is 6ft 6in. Worm box units on the top beam are designed to give it an adjustment of 3in and its setting is effected by means of a hand wheel with reference to a graduated scale. The machine has a stroke of 3in and with the stroke down and the adjustment up there is a die space of 7¾in.

The eccentric shaft is machined all over from a high-tensile steel forging and is carried in cast steel header blocks welded to the side columns. This shaft is driven by a 3 h.p. motor through enclosed single helical gearing on the first motion shaft of which is mounted the flywheel. The machine makes forty strokes per minute and is capable of bending 6ft lengths of 14 gauge mild steel.

Westinghouse Brake and Signal Company, Ltd.

Plating to specification requires accurate knowledge and control of the correct current and time needed to ensure a given thickness of deposit and to obtain repeatability of results in further batches of similar work. For known conditions of solution, temperature and anode-cathode spacing, the thickness of deposit is determined by the current density and the duration of the process. Once the optimum current density has been found, by calculation and by experience, the current to the plating bath can be stated and the duration is determined. Manual control of the current and the time of plating suffers from inherent disadvantages which are eliminated in the automatic plating rectifier equipment demonstrated by the Westinghouse Brake and Signal Company, Ltd., 82, York Way, King's Cross, London, W.1.

This equipment provides for automatic control of the plating time and of the current

which can be held constant at any value within a wide range. In nickel plating the procedure is simple. During the loading of the bath a polarising potential is applied; once the bath has been loaded the current regulating system is set at whatever value of current the work requires. A time switch is then set for the time interval required to produce the minimum thickness of nickel. The operator presses a push button to switch the plant over to automatic operation; the current remains within ±5 per cent of the preset value, until the time cycle has been completed, under the control of the time switch, when the plating current is reduced automatically to a low value sufficient to prevent depolarisation. At the same time, a warning is given so that the operator can unload the bath ready for the next batch of work; should the power supply be interrupted during the plating process, a battery provides the polarising potential through a half-wave rectifier.

Recording instruments can be included in the equipment, allowing a permanent record of current, time, bath temperature and pH value to be kept.

Boilers and Accessories

Amongst the exhibits on the stand of the Brockhouse organisation was the "Watts" boiler, which is being made by the Brockhouse Heater Company, Ltd., of Hill Top, West Bromwich. It is a very compact gravity-feed boiler, which has been designed for service where the heat load ranges from 35,000 to 100,000 B.Th.U. per hour.

In addition to a 7ft diameter, 15ft high multitubular vertical boiler on its own stand, Cochran and Co., Annan, Ltd., of Annan, also had one of similar design, 5ft diameter, 11ft 3in high, with a working pressure of 100 lb per square inch, on the stand of Prior Stokers, Ltd. This boiler was to be seen working in conjunction with a Prior "bunker-flow" stoker, taking coal direct from a bunker at the rear of the boiler. The steam raised was being used for process work on the neighbouring stand of I.C.I., Ltd.

Waste heat recovery was the subject of the exhibits on the stand of Senior Economisers, Ltd. The H type gilled tube, which is the basic feature of this company's various types of economiser, is suitable for recovering waste heat from the flue gases of steam-raising plants, kilns, furnaces and other sources of waste heat. The main application, however, is in central power stations and industrial steam-raising plants.

Included in the products of International Combustion, Ltd., of Derby, was a tangential firing corner pulverised fuel burner incorporating a tilting feature to give an adjustable furnace performance. A new form of interlocking louvre developed by the firm has been designed to maintain a high standard of air distribution over the whole working life of the travelling grate.

Nu-Way Heating Plants, Ltd., of Birmingham, demonstrated two models of automatic oil burners for boilers. The smaller burner is designed with a maximum delivery of 1¾ gallons of distillate fuel oil per hour for boilers up to 166,000 B.Th.U. per hour. The larger burner has a delivery of 5 gallons of oil per hour and is intended for boilers of up to 500,000 B.Th.U. per hour.

Instruments

The Baldwin Instrument Company, Ltd., Dartford, Kent, showed a comprehensive range of electrical instruments for scientific and industrial use. Thomas Mercer Ltd., St. Albans, exhibited a variety of chronometers, dial indicator gauges, time switches and clock movements. C. F. Casella and Co., Ltd., Regent House, Fitzroy Square, London, W.1, displayed a selection of scientific and meteorological instruments. Alltools, Ltd., Great West Road, Brentford, Middlesex, exhibited instruments, including Geiger counters, for radio activity measurements and spectrum analysis.

Sangamo Weston, Ltd., Enfield, Middlesex, showed examples of their electricity meters, time switches, moving coil relays and electrical instruments. Smith Industrial Instruments, Ltd., London, N.W.2, occupied a stand with its subsidiaries, A. T. Instruments, Ltd., and David Harcourt, Ltd., and the joint display included tachometers, speed and revolution indicators, thermostats and counting devices. Record Electrical Company, Ltd., exhibited a wide range of electrical measuring instruments. Foster Instrument Company, Ltd., Letchworth, Herts, showed a variety of equipments for the accurate measurement and control of temperature.

Other Exhibitors

In addition to its well-known dairy equipment, the Geo. H. Gascoigne Company, Ltd., of Reading, exhibited structures such as work benches, pedestrian guard railing, storage racks and others made from steel tubes and "Kee Klamp" fittings. Rubery, Owen and Co., Ltd., of Darlaston, and its associated companies showed pressings of all types and machined components, such as bolts and nuts, in addition to examples of sheet metal work. On four stands, two of which were out of doors, Stewarts and Lloyds, Ltd., Brook House, Upper Brook Street, S.W.1, and its subsidiary companies had on view many applications of steel tubes and pipe joints. A Brook footbridge in four sections on welded tubular piers was exhibited on the company's outdoor stands.

A new method of making concrete by first placing dry large aggregate and then pouring a grout over and into the aggregate was demonstrated by Cheecol Processes, Ltd., 40, Broadway, Westminster, S.W.1. Thompson Brothers (Bilston), Ltd., had arranged on its stand a sectioned thermostatically controlled gas-fired galvanising plant, a circular stainless steel tank for bulk storage or transport of liquids, and a combined pumping and metering unit for petrol or oil, for use with road vehicles or stationary points. Marine lighting equipment formed part of the exhibits of Chance Brothers, Ltd., 28, St. James's Square, W.1, whilst Austinlite Ltd., a subsidiary company, exhibited a small self-contained a.c. 400W standby generating plant, designed for automatic operation.

On the stand of the J.L.S. Engineering Company, Ltd., King's Norton, Birmingham, was to be seen one of the firm's gas-fired, large-volume, low-pressure, hot air circulating furnaces, designed for glass annealing, at temperatures ranging from 500 deg. to 550 deg. Cent., through a very slow cooling curve. This type of furnace has a range of 50–550 deg. Cent. plus or minus 2½ deg.

English Electric Company, Ltd., Queens House, Kingsway, London, exhibited fusegear, instruments and meters, electronic equipment, welding plant and domestic appliances. The Marconi group of companies, Marconi House, Chelmsford, occupied a stand devoted to modern radio and radar equipment for use on land, at sea and in the air. Murex, Ltd., Rainham, Essex, illustrated its products with a display of metals and alloys, both ferrous and non-ferrous. The Edison Swan Electric Company, Ltd., 155, Charing Cross Road, London, W.C.2, included among its exhibits an electronic low-frequency wave analyser, which has numerous potential applications. The Quasi Arc Company, Ltd., Bilston, Staffs, showed two new portable petrol-electric arc welding sets, and some recently introduced types of electrodes. Murex Welding Processes, Ltd., Waltham Cross, Herts, included in its display of welding plant a mobile 400A diesel engine-driven arc welding set. British Insulated Callender's Cables, Ltd., Norfolk Street, London, W.C.2, showed a range of cables and boxes, crane collector equipments, capacitors and automatic welders.

Higgs Motors, Ltd., Witton, Birmingham, exhibited a representative selection of standard squirrel cage and slipring motors, incorporating post-war improvements in design. Associated Electronic Engineers, Ltd., Dalston Gardens, Stanmore, Middlesex, showed electronic equipment for the domestic and industrial markets. Gent and Company, Ltd., Leicester, displayed a variety of apparatus including impulse clock movements, synchronous clocks, process timers, signalling apparatus and call systems. Scophony, Ltd., Wells, Somerset, exhibited dynamic balancing equipment, small high-speed induction motors, and a novel a.c. torque motor. The exhibits shown by Sunvic Controls, Ltd., Stanhope House, Kean Street, London, W.C.2, included a high-sensitivity recorder and a thermocouple controller.

Blast Furnace Development

In aiming at increased production from existing furnace plants in the United States, continual use of scrap in the charge is one effective method of increasing the daily output, but this method is affected by the general shortage of scrap. In the increasing use of sized coke, stone and ore, one furnace has used nodulised Mesabi ores with the result of 13·6 per cent increase in iron production, 8 per cent decrease in coke consumption, 20 per cent decrease in flux consumption, and 9·3 per cent decrease in flue dust. Another method proposed for higher furnace capacity is to use belt conveyors instead of the usual skip hoists for feeding the charge to the furnace top. Control of the moisture content of the blast is claimed as a means of increasing the uniformity of the iron; several operators aim at lowering the moisture to about 3 grammes per cubic foot. Others, however, prefer to add moisture to the air by steam, in order to level off the variation from day to day, thus obtaining more uniformity in the working of the furnace and in the resultant product. Another line of experimental development is increasing the blast pressure from the normal 2 lb pressure up to 10 lb, and in this way increasing the tonnage output. Carbon linings of the hearth are being considered, of both the block and rammed types, because of the chemical inertness to blast furnace slag, the resistance to distortion at high temperature, and the high strength at high temperatures. In 1946, experiments began in the use of commercially pure oxygen in blast furnaces to increase flame temperature and thus shorten the melting time. Sponge iron, prepared by direct reduction of iron ore of temperatures below that required for smelting, is still in the experimental stage. Its use as scrap in steel furnaces depends largely upon its cost in comparison with that of normal scrap. While it may be produced by solid or gaseous fuel, natural gas has not been satisfactory owing to its large content of water vapour and carbon dioxide.

The Flood Problem: Its Philosophy and Its Facts

By REGINALD ARTHUR RYVES, M. Cons. E.

THE flood problem in Great Britain is simply the issue as to whether we shall act in harmony with natural law as governing the movement and action of water and the existence, in one place or in another, of water-borne and water-deposited earthy materials; or, on the other hand, persist in acting, as now, in defiance of that law.

The River's Mission

Rivers behave as organisms fulfilling an appointed mission and forcibly resenting any interference with the useful task of creating productive lands; by lowering the hills and uplands among which they are formed by the confluence of torrents and streams of great abrasive power; by deepening and widening the glens by which they approach the lowlands and forming in them strips of good pasture land; and by widening the lowland valleys and raising their ground levels with accretions of rich soil brought down from higher up their courses or excavated from the feet of the valley slopes.

The powers of mankind cannot change the river's purposes, but we can choose the places where silt shall be deposited, and anticipate or hasten—by works of widening and deepening the river channel and smoothing its banks, or by making new cuts across bends—the bringing about of the more rapid flow which, if left to itself, the river might take many centuries to achieve.

Storage of Flood Waters

Measures of flood control may be those of the temporary storage of water, in reservoirs of large capacity, the water being released gradually to maintain a desired flow in the river; or rapidly, in anticipation of a flood. Because a large proportion of the silt is deposited in such reservoirs, the rate of deposit in flood channels and flood relief areas—"flood plains"—is slowed down. This function of the reservoirs may be combined with that of regulated inundation, where flooding and the deposit of silt may be preferable to immunity from flooding, as in many grazing grounds in English river valleys. To the slower rate of silt deposit there corresponds a slower rate of the rise of flood levels, decade by decade, deferring, but not indefinitely, the time when some built-upon areas, now just inhabitable, will become uninhabitable.

Attempts at Coercion

The rates of rise of ground levels on lands flooded from time to time have been rapid enough to have caused, within living memory, the attainment of increasing flood water depths as measured from an Ordnance datum. But that is not the whole story, for the floods become deeper as measured from rising ground surfaces, and the cause of that deepening and the main cause of destructive flooding generally is that the flood channels and, in many cases, the flood plains have to a very large extent been denied to the rivers.

The flood channel was formed when the bed of the river was at a higher level than now—at any particular cross section of the valley—by the action of the river meandering from side to side of the valley bottom, eroding the feet of the hill slopes and from time to time returning to excavate material which it had deposited. This general levelling process, when it first took place in an earlier epoch, produced a flood channel which, another being formed in a later epoch, became a plain liable to flooding by the greater natural floods or by the floods of increasingly higher levels caused by encroachments on that area and on the flood channel at a lower level. Large areas have been protected by flood banks, or their levels raised by tipping materials. Also, the flood plain loses that character where its surface is raised by silt brought down by small streams and deposited upon it.

"Reclamation"

Encroachments on the flood plains and flood channels of rivers have been of very large extent in nearly all the larger valleys, and the results have been felt with ever-increasing severity, culminating in the recent demonstration of the powers of rivers to reclaim their flood channels and to flow again over the areas formerly available for the limiting of rises in flood levels. The results of protecting too large a proportion of the originally flooded area were also recently demonstrated in dramatic fashion in the valleys of the Mississippi and Ohio, and now the same Nemesis has overtaken us. Of the encroachments of quite recent times, those of the Metropolitan Water Board—which merely carried out works necessary to ensure the water supply of London, as a preferable alternative to the costly project of obtaining water from Wales—are notable for the large aggregate of the areas denied to the River Thames and Lee, by the creation of great reservoirs. That measures, the necessity for which should have been realised before those reservoirs were created, were not undertaken when they made the necessity more urgent is no fault of the Board, the responsibility being that of other authorities including the successive Governments.

As regards encroachments on the naturally flooded flats of the River Lee, Mr. B. Howarth, Engineer to the Lee Conservancy Catchment Board, stated, in January, 1937, that in the previous fifty years, in the valley of the Lee, for the first 14 miles from its junction with the Thames, the spill area had been encroached upon by houses, factories and railways, after the levels of the land had been raised; while a large number of reservoirs for the water supply of London had been built in the area; and the few marshes which remained as open land had been acquired for recreation grounds and either raised in level or protected by flood banks. Since then the policy of creating new reservoirs in the Thames and Lee valleys has been continued. Similar descriptions of encroachments, largely in the flood channels, might be made with respect to most other large alluvial valleys in Britain—perhaps more especially in England.

The Fenland

The action of rivers entering the Fenland in depositing silt, and their requirements with respect to the limiting of heights of flood levels, are the same in essentials as are those of rivers in alluvial valleys, though the area was, in character, a deltaic and largely tidal estuary, receiving the waters of the River Ouse, 100 miles in length; the Witham, 80 miles; the Nene, 70 miles; the Welland and the Glen. The situation that may be brought about by the narrowing of flood channels and by denying to the river its use of flood relief areas is much more perilous, while the losses when the defences are breached are enormous, much of the area being below high tide level. In another very important respect the conditions are entirely different from those in alluvial valleys, and, while recognising that the claiming of a large proportion of the area for agriculture was a wise policy, engineers may now see the cause of the successive flooding of those lands as lying in their own failure to realise that the flows of the rivers towards the sea, at the lower tide levels, would not suffice to discharge enough water to ensure immunity from flooding of the protected lands. The whole area claimed, largely in the seventeenth century, including islands which form but a small proportion of it, is about 2000 square miles. A proposal for the provision of additional large pumping stations for lifting water over the sea wall was not adopted; nor was the scheme, designed to protect half a million acres—781 square miles—considered by Parliament in 1931. Mr. J. A. de Rothschild, member of Parliament for the Isle of Ely, speaking in the debate on that proposal, estimated the "potential loss" occasioned by the then recent floods as between one and two million pounds. How much greater the loss may be was not realised by Parliament, it seems.

Specific Schemes

As to flood control measures in the Thames Valley, Mr. A. B. Buckley's fully worked out proposals, of 1930, included the creation of four reservoirs, on tributaries of the river, to hold 39,730 million gallons (6359 million cubic feet) for flood control and regulation of flow. Mr. G. Bransby Williams' scheme, of 1937, provided for a storage of about 26,875 million gallons (4300 million cubic feet) for flood control, in a total storage of 109,400 million gallons (17,500 million cubic feet), the scheme including the impounding of sufficient water to ensure adequate supplies for London and the other areas supplied by the Metropolitan Water Board. Mr. Buckley's provisions would retain, during floods, a volume of water which would flood 114 square miles to a depth of 2ft, and Mr. Williams' scheme, for the retention of a volume which would cover 77 square miles to 2ft depth. The cost of Mr. Buckley's scheme was estimated as £4,000,000—say, £7,100,000 now—and Mr. Williams' as £7,400,000—say, £12,000,000 now.

Mr. Williams put forward at the same time a similar scheme for the River Severn, to cost £10,650,000—say, £17,100,000 now. That such works, the creation of flood control reservoirs, will have to be undertaken in the basins of the rivers flowing to the Fenland is certain, unless the far from attractive and very costly alternative of pumping on a great scale be preferred. It is no less necessary, though not so urgent, to make similar provisions in the basins of the Thames, Severn, Trent and many other rivers.

The Late Mr. W. H. Morton.—We regret to have to record the recent death, which occurred suddenly, of Mr. William H. Morton, director and secretary of Bruce Peebles and Co., Ltd., Edinburgh.

High Creep Strength Austenitic Gas Turbine Forgings*

By D. A. OLIVER, M.Sc., F.I.M., F. Inst. P.,† and G. T. HARRIS, M.A., F. Inst. P.†

EARLY attempts to meet the need for materials having high strength properties at high temperatures were on a small scale and somewhat faltering. However, it is interesting now to trace in Great Britain how an initial foothold was secured by studying the precipitation-hardening, titanium-bearing, 18/8 type stainless steels, followed by the late Dr. W. H. Hatfield's Rex78, which played an important *rôle* in early developments. This was superseded later for blades by the Nimonic 80/20 nickel-chromium alloys.

Towards the end of 1943 the place of the simpler austenitic stainless steels was taken by the more complex niobium-bearing stainless steel "G.18B," with the development of which the present authors were particularly concerned. There were, of course, many applications of existing stainless and other alloys made to components operating under less onerous conditions of stress and temperature than those to which discs and blades were subject. Regarding those materials having the highest performance, it would appear that Great Britain secured a pre-eminent position in jet engine development with about only five or six special steels or alloys. This is superficially deceptive, as many thousands of separate experiments were conducted to winnow the wheat from the chaff. It was important also to concentrate on a minimum number of good materials so that the available high-temperature testing facilities could secure the maximum amount of test data. Even to-day there are many gaps in our knowledge and metallurgists and engineers necessarily have to advance with great circumspection.

THE CHOICE OF STEELS FOR GAS TURBINES

In assessing a steel for high-temperature use, especially in land or marine gas turbines, the following characteristics are desirable :—

(*a*) A maximum stress at room temperature of not less than 30 tons per square inch and a 0·1 per cent proof stress of not less than 10 tons per square inch, associated with a percentage elongation (on $L=4\sqrt{A}$) of not less than 10 per cent and an Izod impact value of not less than 10ft-lb.

(*b*) Sufficiently high creep strength characteristics and general consistency in creep behaviour when working stresses have been chosen sufficiently low not to cause the component to fail prematurely.

(*c*) Sufficiently high fatigue strength characteristics at elevated temperatures to cope with the range of fluctuating stress likely to be experienced during the full working life.

(*d*) Freedom from embrittlement and major secular metallurgical changes at the maximum working temperature (either with or without a superimposed stress), and the maintenance of minimum mechanical properties over extended periods of working.

(*e*) Freedom from serious sulphur compound attack by the combustion gas.

Naturally, in dealing with such complex phenomena it is not possible to specify all the necessary requirements precisely, but the above considerations are certainly among the more important.

It is useful to distinguish between highly-alloyed complex steels, which can be successfully produced for components of limited size like individual blades, and those having attractive properties which are capable of being cast into large ingots and forged into components of appreciable size. It is therefore convenient to divide the subject broadly into rotor steels and blade steels, because what may be feasible for blades does not necessarily hold true for large rotor forgings.

ROTOR STEELS

Up to about 1938 gas turbine rotors working at maximum blade root temperatures of the order of 500 deg. Cent. were usually forged from low-alloy constructional steels or 18/8 stainless, stabilised with additions of titanium. Since 1945 two new niobium-bearing steels have been adopted quite extensively, namely, R.20 and G.18B, which have made history by being first in the field to satisfy the new operating requirements involving blade root temperatures of up to 700 deg. Cent., particularly when using G.18B. The chemical compositions of these steels are given in Table I.

TABLE I.—*Chemical Compositions of Heat-Resisting Steels: Weight per cent*

	Rex.78	Nimonic 80 (U.S. source).	R.22.	R.20.	G.18B.
Carbon	0·07	0·04	0·3	0·14	0·4
Manganese ...	0·80	0·56	0·9	0·8	0·8
Silicon	0·70	0·47	1·3	0·3	1·0
Nickel	18·0	74·23	14·5	14·0	13·0
Chromium... ...	14·0	21·18	25·0	19·0	13·0
Cobalt	Nil	Nil	Nil	Nil	10·0
Tungsten	Nil	Nil	3·2	Nil	2·5
Molybdenum ...	3·75	Nil	Nil	Nil	2·0
Niobium	Nil	Nil	Nil	1·7	3·0
Titanium	0·65	2·44	Nil	Nil	Nil
Copper	3·6	Nil	Nil	Nil	Nil
Aluminium ...	Nil	0·63	Nil	Nil	Nil

The principal object of this paper is to describe some examples of the applications of these steels to gas turbines, and to present data of their high-temperature characteristics which will facilitate design and give an established basis for confidence in their use.

BLADE STEELS

For inlet nozzle blades there is a choice of the 25/15/3 (Cr, Ni, W) stainless steel type (R.22), which is more scale resisting and less strong at temperature than G.18B, which has been adopted with success for operating temperatures not exceeding 900 deg. Cent. For the highest and intermediate temperature stages of the rotor blades two varieties of G.18B are available, namely, "warm-worked" and "solution-treated." For the lower temperature stages R.20 has proved on occasion to be a very suitable alternative.

New materials are just becoming available for still higher blade operating temperatures,

TABLE II.—*Rupture Strength at 816 deg. Cent. of Heat-Resisting Alloys*

Date first available	Material.	Origin.	Stress to rupture 100 hours at 816 deg. Cent., tons per sq. inch.
1936	Rex.78	Firth Vickers	5·5
—	Nimonic 80 (U.S. origin)	International Nickel Co.	7·7*
1943	G.18B	Wm. Jessop	6·5
1947	G.32	Wm. Jessop	12 approx.

including "G.32." Table II gives the stress for rupture in 100 hours at 816 deg. Cent. on a comparative basis.

GENERAL CONSIDERATIONS

During the war rapid development of high creep strength austenitic materials took place because the total working life of gas turbines for aircraft was considered satisfactory if the turbine gave trouble-free performance for fifty hours' running at full load. In other cases this time was extended to 100 hours' total running time, and tests on materials extending to a minimum of 300 hours and in some cases up to 1000 hours were considered more than adequate.

In the marine propulsion field, current demands appear to range for between 2000 hours' and 10,000 hours' satisfactory performance at full rating, although the general position is at present vague on account of the diversity of projects under consideration. Gas turbines in land installations are normally expected to give reliable service for periods ranging between 10,000 and 100,000 hours, with complete overhauls at regular intervals and with replacement of certain parts after stated expected individual lives.

Some of the steels developed for use in aircraft turbines have proved, when operated at lower stress values, to be quite suitable for long-term applications. However, it is not necessarily true that a material satisfying short-term tests will be satisfactory for land and marine use. In Fig. 1 are shown typical curves for actual materials on a basis of stress-to-rupture, and whereas 18/8 low-carbon stainless steel behaves normally, a similar steel with niobium additions which had been cold worked shows a drastic change of slope after 200 hours. It is clear that extrapolating from short-term data in this instance would lead to erroneous predictions of reliability if linearity had been assumed. In the same figure, curves for G.18B and R.20 are also given with the experimental points which summarise the available information. So far as the investigations have proceeded, there is no suggestion of lack of linearity in these cases. In other cases the sudden change of slope probably occurs on account of major metallurgical changes in the steel which may also be expected to give rise to alterations in other properties, such as percentage elongation, percentage reduction in area and impact strength. In austenitic steels operating at temperatures of 700 deg. Cent. and over, certain metallurgical changes inevitably occur, especially as these steels in most instances are purposely enriched with complex carbides in solid solution to confer high creep strength properties. A summary of new experimental work dealing particularly with the effects on the ordinary mechanical properties of holding G.18B and R.20 steels at elevated temperatures for periods up to 4000 hours is given later. Again, so far as the evidence goes, the conclusions can be drawn that no serious embrittlement occurs, although certain properties change with time to a significant extent.

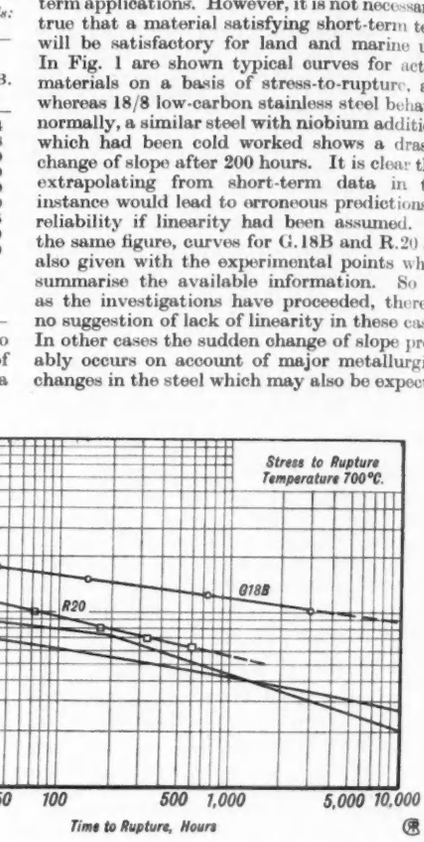


FIG. 1—*Stress to Rupture Curves at 700 deg. Cent. for Various Steels*

SPECIAL PROBLEMS IN THE PRODUCTION OF SOLID ROTOR FORGINGS

Consideration of the processes involved in the production of solid rotors in special steels shows that unusual problems are met with at all the stages of manufacture. The simplified production procedure involves in sequence :—(*a*) Melting, (*b*) casting, (*c*) forging, (*d*) heat-treatment, (*e*) machining, (*f*) examination, (*g*) testing.

Many of the most attractive alloys developed for use in aircraft gas turbines can only be made in high-frequency melting furnaces and are limited to comparatively small forgings. Therefore, for the production of large rotors it is necessary to select a steel or alloy which can be melted in the large melting units usually found in a steelworks. The two steels under consideration, namely, G.18B

* Institute of Marine Engineers, April. Abstract.

† The Research Department, William Jessop and Sons, Ltd., Sheffield.

* Symposium on Materials for Gas Turbines, page 19, 1946, A.S.T.M.

and R.20, are both made in basic-lined electric-arc furnaces of 12/15 tons capacity. This has necessitated the development of special melting techniques, because it is undesirable to employ any melting process which is oxidising. This implies that the melting procedure must in effect conform to the old crucible steel melting practice, but on a very much larger scale with rigorous precautions. Due to the large number of alloying elements the calculation of the charge itself is complex, and great care is necessary to maintain the final composition within the essential narrow limits of specified chemical composition. Care also has to be exercised to maintain the temperature at a level which is not too high to avoid the danger of gas absorption, and extensive use is made of the technique of quick-immersion liquid steel temperature measurement in order to achieve the close control that is necessary. In particular, the casting temperature must be as low as possible consistent with obtaining a properly-fed ingot, so that axial porosity is a minimum.

The selection of the most suitable size of ingot is a compromise between the need for retaining a cross-section sufficiently large to secure a reasonable amount of forging reduction and, on the other hand, avoiding unsoundness in ingots which exceed a certain size.

Skill has to be exercised in the preparation of the ingot for forging, as this process is one of considerable difficulty. The difficulties will be appreciated when it is realised that these steels are designed to have unusually high strengths at high temperatures, so that the forging pressures are considerably greater than those normally employed on simpler steels. This involves close control of soaking times and forging temperatures, because the effect of excessive pressures at an unsuitable temperature invariably leads to central forging bursts. Particular care has to be exercised in the operation of setting-down the ends of forgings to make the shafts, and new methods have been developed to overcome these difficulties.

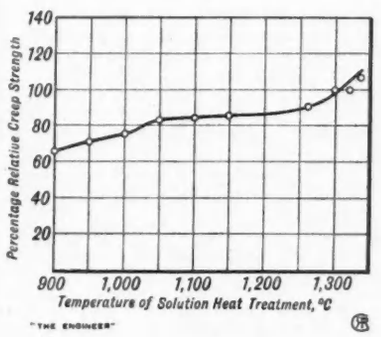


FIG. 2—*Relative Creep Strength at 700 deg. Cent. for Large Forgings in G.18B Steel for Different Solution Heat Treatment Temperatures*

It is desirable to heat-treat the forging from as high a temperature as possible in order to obtain the maximum creep strength at the operating temperature. Fig. 2 shows for a large forging of G.18B the relative variation of creep strength at 700 deg. Cent. with temperature of solution-treatment, and it will be noted that there is a progressive increase of strength almost up to the melting point of the steel. The limit of temperature at which treatment can be carried out is determined by the difficulties of heating a large mass of steel while maintaining both close control and temperature uniformity, but it has been found possible to employ temperatures of the order of 1200 deg. Cent. in suitable furnaces.

The machining of austenitic steels has always been a matter of some difficulty due to the tendency to work-harden. The increased experience gained during the last few years on the machining of thousands of discs for aircraft gas turbines has shown that the problem is largely one of the selection of the most suitable tools and machining conditions, and former difficulties have been overcome.

The examination of these special rotors has raised new problems, as austenitic steel forgings tend to have a structure at their centre which is slightly "loose" compared with their ferritic steel counterparts. Such looseness, if not too severe, can be tolerated in austenitic steels, as they are largely insensitive to notches and to the propagation of cracks. It is necessary, however, to check that any porosity that is present is not severe, and most valuable non-destructive tests have been made using the Hughes supersonic flaw detector.

The ordinary mechanical tests at room temperature do not indicate whether the steel has the desired strength at elevated temperatures. Special tests are therefore applied to test pieces cut from rings trepanned from the surface of the forging. These tests mainly comprise short-time creep tests for durations of the order of 100 to 300 hours, and are sufficient to check that the material conforms to the anticipated standards. These standards are set up after the full properties of the steel have been determined by long-term tests.

(To be continued)

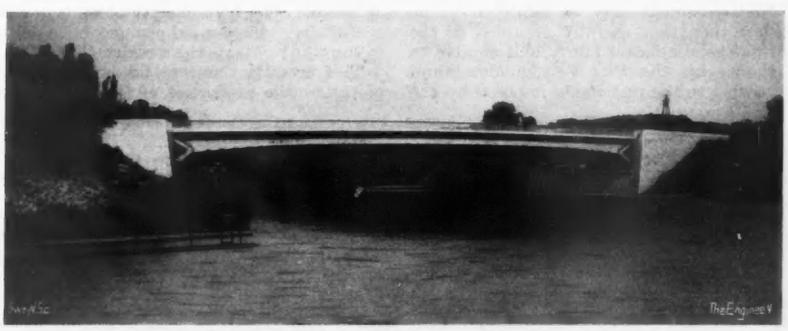
Luzancy Bridge, France

LUZANCY Bridge, on the river Marne, recently rebuilt to replace a bridge destroyed during the war, is of interest as being one of the first important structures in France to be built with pre-stressed reinforced concrete, by a process of Monsieur Freyssinet, a former engineer of the Ponts et Chaussées.

The destroyed bridge was of the suspension type, with a central span of 55m, carrying a roadway and two footways. It was blown up by French engineers in 1940 to cover the retreating armies, and was replaced in 1941 by a temporary bridge with a 16-ton load capacity.

When the construction of a permament structure was under consideration, shortage of steel precluded a design with a steel arch of the required dimensions, which in any case would have meant rebuilding the foundations of the old bridge. It was therefore decided to build a single span concrete bridge of the type shown in the illustration. There was found to be no need to widen the old foundations in order to give a 6m width of roadway. Furthermore, the quantities of steel and cement required, compared with an ordinary reinforced concrete bridge designed for the same load, was nearly 50 per cent less. Three tubular concrete girders support the roadway, giving a single 55m span over the river, with sufficient clearance underneath for the passage of tugs and barges. The decking consists of one slab of concrete, stretching from one end of the bridge to the other, on which the concrete roadway rests. The girders are initially compressed by high-tensile steel wire reinforcement.

Each girder was made up from 22 units, each weighing 5 tons, pre-cast in vibrated concrete. Each girder, when completed, weighed 122 tons, and was erected in three sections, the two end sections each weighing 18 tons, and the central section 86 tons. Throughout the construction work, river traffic was uninterrupted. The total test load applied to the structure before it was opened for service was 244 tons, producing a deflection of 26mm.



LUZANCY BRIDGE, RIVER MARNE

British Standards Institution

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria Street, London, S.W.1. The price of each specification is 2s. 3d. post free, unless otherwise stated.

RUBBER AND P.V.C. INSULATED CABLES

No. 7 : 1946. Wartime conditions hastened the introduction of P.V.C. (polyvinyl chloride) insulated cables as an alternative to rubber-insulated cables, and a number of modifications to the B.S. Specification for Rubber Cables were made to meet these conditions.

Some of these modifications are now being retained as permanent revisions of the specification, others are being retained for the time being with the intention of being dropped eventually, while others have now been entirely cancelled. This state of affairs has been put into effect through the publication of this 1946 edition of B.S. 7, which is accompanied by a supplement relating to P.V.C. cables and a leaflet entitled "Transitory Relaxations." All the usual features of this well-known specification are retained in substance, but various changes in detail have been introduced to take account of the changeover from war to peace conditions referred to above. The main specification and the supplement are issued as a single volume (B.S. 7 : 1946), at 3s. 6d. post free, and the "Transitory Relaxations" are issued separately under the reference PD. 540.

ACID-RESISTING SILICON IRON PIPES AND PIPE FITTINGS

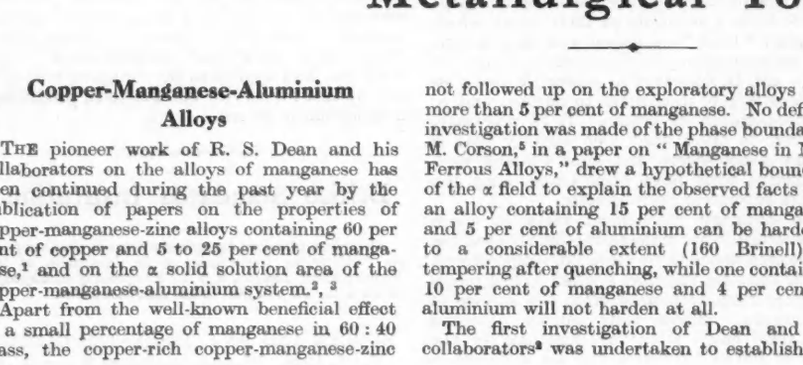
No. 1333 : 1946. This new standard deals with the dimensions of high-silicon pipes and pipe fittings from 1in to 12in nominal bore, which are extensively used in chemical plant and where excessive corrosion is inevitable or anticipated. The minimum silicon content to give maximum corrosion-resisting properties is generally agreed to be 14·25 per cent. Silicon iron is more brittle than ordinary cast iron and, in consequence, requires greater care and precaution in handling and transport. It is more difficult to cast and is more liable to porosity and distortion than ordinary cast iron. There is particular difficulty in casting silicon iron pipes with integral flanges and, in this standard, flanged pipes are specified with 45 deg cone ends for assembly by halved loose coupling flanges of ordinary cast iron impinging upon the 45 deg cone ends of the pipe. The standard also deals with spigot and socket pipes, the spigots of which are generally similar to the ends of the cone-end pipes, thus allowing interconnection between cone end and spigot and socket pipes. The sockets of the spigot and socket pipes will also accept the plain spigots of chemical stoneware pipes of the same nominal bore, so allowing interconnection between silicon iron socket and stoneware spigot. The fittings included comprise elbows, bends, tees and crosses for both flanges and spigot and socket pipes.

Metallurgical Topics

Copper-Manganese-Aluminium Alloys

THE pioneer work of R. S. Dean and his collaborators on the alloys of manganese has been continued during the past year by the publication of papers on the properties of copper-manganese-zinc alloys containing 60 per cent of copper and 5 to 25 per cent of manganese,[1] and on the α solid solution area of the copper-manganese-aluminium system.[2, 3]

Apart from the well-known beneficial effect of a small percentage of manganese in 60 : 40 brass, the copper-rich copper-manganese-zinc alloys have few outstanding possibilities; but the copper-manganese-aluminium alloys show more variety of properties and, like the copper-nickel-aluminium and the copper-manganese-nickel alloys, are subject to temper-hardening. The benefit to be derived from this treatment may be expected to be much less than that usefully obtained in the copper-manganese-nickel alloys and similar to that shown by the copper-nickel-aluminium alloys, owing to the restriction imposed by the presence of aluminium on the limits of composition of the ductile alloys.



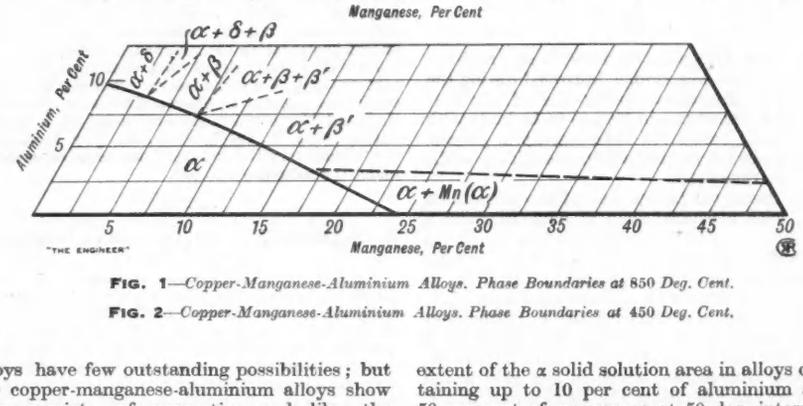


FIG. 1—*Copper-Manganese-Aluminium Alloys. Phase Boundaries at 850 Deg. Cent.*

FIG. 2—*Copper-Manganese-Aluminium Alloys. Phase Boundaries at 450 Deg. Cent.*

Hitherto the principal studies of the system have been focused on the Heusler alloys containing 10 to 30 per cent of manganese and 9 to 15 per cent of aluminium. These investigations concern ferro-magnetic properties, and such alloys being brittle are, of course, unsuitable for general engineering purposes. W. Rosenhain and F. C. A. H. Lantsberry[4] examined alloys likely to receive engineering applications and containing up to 10 per cent of aluminium and 10 per cent of manganese, but work was not followed up on the exploratory alloys with more than 5 per cent of manganese. No definite investigation was made of the phase boundaries. M. Corson,[5] in a paper on "Manganese in Non-Ferrous Alloys," drew a hypothetical boundary of the α field to explain the observed facts that an alloy containing 15 per cent of manganese and 5 per cent of aluminium can be hardened to a considerable extent (160 Brinell) by tempering after quenching, while one containing 10 per cent of manganese and 4 per cent of aluminium will not harden at all.

The first investigation of Dean and his collaborators[2] was undertaken to establish the extent of the α solid solution area in alloys containing up to 10 per cent of aluminium and 50 per cent of manganese at 50 deg. intervals between 400 deg. and 900 deg. Cent. The results were given in diagrams, two of which are reproduced here on a reduced scale. The constitution at 850 deg. is very simple (Fig. 1). On cooling to 450 deg. complicated changes have occurred in the alloys outside the α region (Fig. 2).

This investigation was followed by a study of the tensile properties of the alloys as cold-rolled to one-sixteenth in sheet and as annealed for one hour at 700 deg. and at 650 deg. Cent. and quenched in water.[3]. The hardness and strength are primarily controlled by the aluminium content; but, when manganese exceeds 25 per cent, hardness well in excess of that of the binary copper-aluminium alloy is obtained. Some alloys which consist of a single phase at 700 deg. Cent. fall within the α+Mn (α) field at 650 deg. and show a higher strength and hardness, with lower elongation, when quenched from that temperature. Table I shows tests on two single-phase alloys quenched from 700 deg. Cent. The tensile strength of the same alloys is increased to 39 tons and 33·5 tons per square inch respectively when they are annealed at 650 deg. and quenched, since this treatment produces a duplex structure.

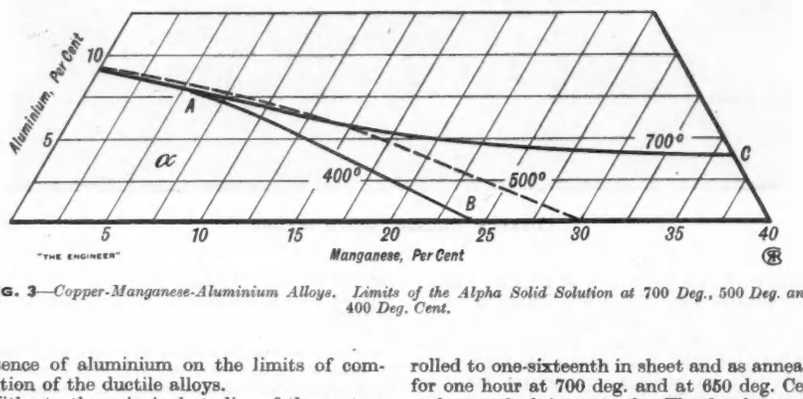


FIG. 3—*Copper-Manganese-Aluminium Alloys. Limits of the Alpha Solid Solution at 700 Deg., 500 Deg. and 400 Deg. Cent.*

TABLE I.—*Tensile Properties of Alloys Annealed One Hour at 700 Deg. Cent. and Quenched in Water (α Solid Solution)*

Aluminium, per cent	2·5 ...	4·5
Manganese, per cent	42·5 ...	30
Limit of proportionality, tons per square inch	9 ...	7
Yield point (0·2 per cent extension), tons per square inch ...	13 ...	11
Ultimate tensile strength, tons per square inch	31 ...	29
Elongation, per cent	40 ...	50

The boundaries of the α solid solution at 700 deg., 500 deg. and 400 deg. Cent. are shown in Fig. 3. Alloys within the region which remains α at all temperatures can be hardened only by cold work. Within this class is the commercial electrical resistance alloy, Kumanal, containing about 10 per cent of manganese and 2 per cent of aluminium, with a yield point and tensile strength in the annealed condition of about 8 tons and 24 tons per square inch respectively. To secure temper-hardening the composition should fall above, and to the right of, the line AB in Fig. 3, and preferably, it would seem, within the triangular area between AB and AC. A thorough exploration of the properties of alloys in this region after quenching from 800 deg. Cent. and prolonged tempering at about 400 deg. Cent. might be expected to yield interesting results. The investigations referred to above have so far not been directed to the determination of the maximum temper-hardening effect.

It may be added that the α boundary is likely to be affected to a considerable degree by the presence of iron or silicon. Copper-manganese alloys with more than 20 per cent of manganese are subject to temper-hardening owing to the change of Cu-Mn(γ) solid solution to Cu-Mn(α) solid solution, but temper-hardening can occur with a much lower manganese content in the presence of 1 per cent or 2 per cent of iron or upwards of 0·5 per cent of silicon. In the presence of small quantities of other elements alloys giving a useful degree of temper-hardening may thus also be found within the limits of the α solid solution for the pure alloys.

REFERENCES

1 *Metals Technology*, Jan., 1946, Tech. Publn. No. 1956.
2 *Metals Technology*, Oct., 1946, Tech. Publn. No. 2099.
3 *Metals Technology*, Feb., 1947, Tech. Publn. No. 2142.
4 "Proc.," Inst. Mech. Engineers, 1910, page 119.
5 "Trans.," Amer. Inst. Min. Eng., 1928, Vol. 78, page 483.

Alloys for Marine Propellers

A PAPER by Dr. R. Beeching, on "Alloys for Marine Propellers," followed by an interesting discussion, is reported in the January issue of the "Transactions" of the Institution of Engineers and Shipbuilders of Scotland (Vol. 90, 1946–47, page 203). To meet requirements, an alloy should be easy to cast and to machine, and the propeller if damaged should not be difficult to repair. The alloy should be sufficiently strong to resist distortion under load, and should exhibit adequate ductility under impact stresses. It must, of course, be resistant to corrosion and to mechanical erosion by sea water. As pointed out by Dr. Beeching, resistance to cavitation-erosion has become an increasingly important factor with increase in ship and propeller speeds, and it was mainly with this property in view that his recommendations were made. As a result of experimental work on cavitation-erosion, he concludes that an α+β alloy with copper 70 to 72 per cent, zinc 22 to 26 per cent, and aluminium 4 to 6 per cent, while possessing adequate mechanical properties, should have a

resistance to erosion about twice that of the Admiralty propeller bronze generally used.

In the copper-zinc-nickel alloys two promising types were found, the $\alpha+\beta$ alloys containing about 15 per cent of nickel and the α alloys containing 20 to 30 per cent of nickel. Although possessing superior mechanical properties which would render them less subject to cavitation erosion, these alloys are not so resistant to sea-water corrosion as the copper-nickel-aluminium alloys. Alloys of the Monel metal type, with 3 to 4 per cent of aluminium, give evidence of outstandingly good resistance to cavitation erosion, a representative composition being copper 28·5 per cent, iron 1·4 per cent, manganese 1·5 per cent, aluminium 3·5 per cent, and the balance nickel. Both the author and the speakers in the discussion were agreed that the ultimate choice must be in the nature of a compromise, and the proposed high-nickel alloys show practical disadvantages in cost and in casting and machining difficulties. Nevertheless, the evidence clearly showed the advantage of the presence of nickel in alloys for high-performance propellers, and it seems probable that with well-directed effort, some of the technical difficulties associated with the use of alloys with relatively high nickel content will be overcome.

Powder Metallurgy: Some Queries

By H. W. GREENWOOD*

Most engineers and metallurgists have a fairly clear idea of what powder metallurgy claims to do in these days, but for many of them it is no easy matter to accept the products of powder metallurgy at the powder metallurgists' valuation. Their doubts appear to be confirmed because the average results of mechanical tests on the products of powder metallurgy are usually of a low order. A very large number of parts produced by powder metallurgy are not, however, highly stressed in service, and the loads they are required to carry are well within their capacity, though there are certain directions in which properties may leave something to be desired. An example would be where the part was called upon to offer rather extensive impact resistance, but such cases are rare and should always be judged with a full examination of all relevant data. Another case that has given rise to discussion is that of gears. Here it must be remembered that the size of the part determines to a large extent the load which can be imposed upon it. Most gears made by powder metallurgy are used as pump gears or as members in a train of reducing gears; they are usually of the order of, or less than, an inch in diameter and the stresses they will be subjected to in service are well within their capacity. It is also often overlooked that small iron gear-wheels can be successfully carburised, thus reducing the wear factor. Still confining our consideration to iron parts, it has to be pointed out that there are numerous attractive possibilities open to the powder metallurgist, if he will only experiment. Hitherto he has largely followed the line of least resistance and done the easiest thing, but it should be possible to improve materially the mechanical properties of iron and steel components by more careful study of particle size distribution so that optimum physical properties are ensured from that point of view. Moreover, the use of additions of other elements which have notably improved the mechanical strength of iron and steel as well as rendered control of shrinkage and growth easier is a possibility of very real importance. Not only are there possibilities of enhancing mechanical properties over a very wide range of ferrous alloys, but there are also good prospects of providing a surface treatment giving high resistance to atmospheric influences, should such be required.

Mechanical Properties

It may be asked if it is possible to quote average figures for mechanical properties. The answer is yes; good general results can be quoted, but the properties of compacts are so dependent on the type of powder used that great care must be taken to see that only fair average figures are given. For example, taking iron powder, oxide-reduced, the ultimate tensile strength in tons per square inch of a large number of careful experiments† ranged from 4·19 tons to 20·07 tons per square inch, but the average of all tests was 7·65 tons per square inch. A similar range of experiments using electrolytic iron, other conditions being the same, gave ultimate tensile strength of from 4·09 to 10·31 tons per square inch, and an average figure of 7·11 tons per square inch. Obviously, in both these cases the average figures did represent something that could be borne in mind and equally in both cases the figure appeared low as compared to figures for ferrous metals other than very ordinary cast iron. Suppose, however, that we consider the powder product made into porous bearings, say, 1in to 2in long, and 1in to 1¼in in diameter, these bearings would have to carry loads of the order of only 60 lb to 100 lb per square inch. That is one very important reason for saying that the engineer may often demand very much better physical properties than the duty of his parts really calls for. It is also a justification for saying that except in the rarest cases, parts produced by powder metallurgy have strength and other properties fully adequate for their purposes. Bushes carrying heavy loads rarely, if ever, have to meet 3000 lb per square inch or under 1½ tons per square inch.

Many of the small parts produced by powder metallurgy such as cams, bushes for dynamos, or small motors, rotors, pole pieces, magnets, &c., do not call for outstanding physical properties.

Limitations of Form and Size

Another query often put is whether there are not grave limitations to the form or the dimensions of components producible by powder metallurgy and does not this constitute a serious disadvantage? Taking form and dimension, it is true that one cannot fabricate certain types of part; for example, it is not practicable to make a very large part very long, compared with the width of the section. The reason for this is that pressure in the press is exerted top and bottom only and this, plus internal friction, causes poor pressure distribution. Therefore, the ratio of length in the direction of pressing compared with the width or diameter of the piece should not be greater than four to one. That means, in the case of a sleeve, for instance, the sleeve can be 4in high and 1in or more in diameter, but it would be unwise to make a sleeve 8in high and only 1in across, because the pressure gradient from top to bottom of the pressing would be too great, and the density of the pressed metal would vary, with possible distortion trouble during sintering.

There are also limitations to shape, due to the dies used and the fact that metal powders do not flow as a liquid or a molten metal will. As a result, it is not possible to press or mould articles with re-entrant angles or re-entrant grooves, nor can one mould external or internal screw threads in the press; these have to be machined later. On the other hand, there are very many complex shapes which would provide plenty of headaches for the machinist that can be made without a trace of difficulty by powder metallurgy.

A very common question is: "What is the largest part so far made by powder metallurgy?" It is difficult to say, but so far as general practice is concerned the largest parts we know of are bearings, made in the U.S.A., some twenty or more inches in diameter and weighing about 200 lb. It is pertinent to point out that such large parts are quite special in nature and that generally there are important economic reasons why the production of very large parts should not be undertaken.

Cost and Life of Dies

A much more intelligent question would be about the cost and the life of dies. Dies are expensive; they may cost anything from just over £20 to several thousands of pounds. That, at once, provides an important limitation in powder metallurgy, namely, that it is a process for large quantity production. As a very rough rule, it is generally accepted that lots of less than 10,000 parts are not likely to prove economical, although there have been exceptions where as few as 4000 or 5000 parts have justified preparing dies for a very special purpose, that could stand an almost inordinately high cost. As to the life of a die, no one answer can be given, for wear depends upon many factors; material of the die and powders, hardness of powder being pressed, extent to which lubricant is used on die walls, and rate of operation. As a rule, in ordinary commercial practice, we should expect an output of at least 100,000 pieces before the die showed appreciable wear, and in the United States the manufacturers of bearings and small parts usually allow of a wear on the walls of 0·002in (2mils) before the die is withdrawn for reconditioning by chromium plating and repolishing.

Advantages of the Method

A final query is fairly common and also very reasonable. What are the advantages which powder metallurgy offers over other methods? Without attempting to place them in any order of priority, we should say that they are, among others:—

Production of alloys and mixtures or laminations of metals quite impossible of achieving by any other method.

Production of components with a guaranteed porosity, and also a guaranteed pore size. This also includes all the porous metal bearings.

Possibility of combining metals with metal oxides and non-metals and so producing compacts having unique properties not obtainable otherwise.

Saving in production costs by straight pressing and sintering of awkwardly shaped components that would be very expensive to machine.

Production speed. Small parts up to 500 per minute with multiple dies.

Mass production with relatively high precision tolerances.

These are only general queries that appeal to everyone who has even the smallest interest in powder metallurgy; there are many hundreds of specific enquiries that can only be dealt with by experts.

* Powder Metallurgy, Ltd.

† C. J. Leadbeater, L. Northcott and F. Hargreaves: "Some Properties of Engineering Iron Powders," *Journal*, Iron and Steel Institute, Dec., 1946

The Microscope

Metallurgists and engineers whose work involves the microscopical examination of metallic specimens are apt to treat this as a routine procedure and to be content with a reasonably good standard of photo-micrographs. High-grade photo-micrographic work is, however, the great test of accurate technique, and all microscope users who are seriously interested in the structure of metals will wish to obtain the best possible results with the equipment available. As a help to achieving this object a recent book, "The Intelligent Use of the Microscope," by C. W. Olliver (Chapman and Hall, Ltd., 12s. 6d.), should prove to be valuable. It makes clear, even to the beginner, the principles of design of the microscope, its components and accessories including those peculiar to the metallurgical microscope, and provides a framework of theoretical knowledge readily applicable to microscopy in its widest aspects. This, coupled with the practical advice contained in the book, should enable anyone using the microscope in technical practice to select his equipment efficiently and to settle down with discrimination to the avoidance of unnecessary complications when they can effect no improvement, and the use of the most delicate adjustments when critical work is essential.

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NOTICE TO READERS

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TRAINING FOR MANAGEMENT

PERHAPS as a consequence of a few unhappy experiences during the war, some members of the present Government have shown themselves critical of the efficiency of management in this country's industries. One consequence is the setting up, now in progress, with the Government's particular blessing, of the British Institute of Management. Another was the appointment of a Special Committee by the Minister of Education, in agreement with certain professional bodies, including the major engineering institutions, "to advise the Ministry on educational facilities required for management in industry and commerce, with particular reference to the steps to be taken in regard to the organisation of such studies, bearing in mind the various requirements of professional organisations and the need for their co-ordination." That Committee issued its report shortly before Whitsun and its recommendations are summarised on another page of this issue.

To judge by the comparative peace that has reigned for very many years in the engineering industries whilst labour troubles have been chronic elsewhere, no complaint can be directed at the managements of engineering firms that they are lacking in that quality of human understanding which is so essential in the handling of men. Indeed, we should find it surprising were it possible to sustain such a complaint. For the almost universal practice amongst professional engineers of spending several years' apprenticeship in the shops working alongside the men ensures, not only that there shall be an easy friendly relationship between them, but that each shall gain some understanding of the ways of thought and the reactions of the other. Nor, to judge by the remarkable rates of production achieved during the war, does the management of engineering firms seriously fail in organisational efficiency, though in the highly competitive years between the wars profits were often too low to support re-equipment on a satisfactory scale. But though we thus doubt whether general accusations of inefficiency directed against the managements of engineering firms could be substantiated, we do not intend to decry the merits of more positive methods than have been used in the past for the training of managers. Beyond the mention of certain very elementary factors, there is, it is true, very little that can be taught academically about the handling of men. But there is open to academic study the great field covering managerial methods and the functions of management and organisation which contains very much that can well be learnt from books and lectures. It covers, indeed, the whole ground from the matters to be considered in choosing a site for a factory through the lay-out of the buildings, the arrangements for the smooth supply of raw materials, the methods of producing the goods and their distribution to the purchaser up to and including methods of accountancy so that profits and losses may be accurately known. It is, therefore, we think, all to the good that the subject of education for management should have been studied and reported upon by the Committee. We commend, too, the obvious desire of the Committee that any courses in management provided by an educational establishment should conform to some recognised and uniform standards, such as those set by the two syllabuses for a common intermediate examination in management and for a final examination in general management set out in appendices to the Committee's report. The number of courses in management subjects included in the curricula of technical and commercial colleges was growing before the war as a consequence of demands by professional bodies. Without some co-ordination of these demands, considerable overlapping and resultant confusion might well ensue to the ultimate advantage neither of students nor of the colleges and the professional bodies themselves. One criticism, however, may perhaps be offered. The Committee seems over-impressed with the need for educating youth in management. At least among engineers the desire to learn more of that subject arises not in youth, but at a much later stage, when organisational responsibilities often tend to thrust technical problems into the background. Management as a subject is seldom popular with engineering students, who at so early a stage in their careers are deeply impressed by the need to acquire technical proficiency and only very partially aware of the important part their innate abilities to organise and manage may play in later life. What special provision is it proposed to make for the education of older men?

But, however much may be taught about means and methods, the fundamental basis of success in management is an understanding of how to handle men. Not even deep and complete knowledge of organisational and managerial methods can compensate for lack of experience or for psychological inability to understand the workings of the human mind. An almost perfect system must fail if the people concerned in running it are incorrectly handled; whilst a far from perfect system can get along quite successfully if those who operate it understand the weaknesses and imperfections of its human material. There has for very many years been a demand for further academic knowledge, as is well proved by the number of books published on managerial subjects and the wide range of topics covered by them. But such knowledge alone is inadequate. There must be experience, too. May we hope that those who teach will always remember the first of the Committee's "recommendations": "There is no implication in this Report that young men or women can be trained as managers in industry or commerce by following certain courses of study at technical or commercial colleges. Theoretical study alone cannot make a manager."

CIVIL AIR NAVIGATION

WHEN after the First World War civil air lines began their wide development it was natural that the navigational means they employed should follow those which had been found useful in naval and military aircraft during the war years. Two methods long known for the navigation of ships were adapted for aircraft—dead reckoning navigation and astronomical position finding. In dead reckoning navigation the known course and speed of the craft could be used to plot the sea, or air, path, and if tides and winds were sufficiently known the accuracy, for short runs at least, was quite satisfactory. Astronomical navigation called for greater operational skill on the part of the navigator and required a fairly clear view of the sky, a requirement more readily attained in aircraft than in ships, because the former could often rise above obstructing cloud levels. But if aircraft had herein the advantage, they had difficulties of their own in the usual absence of any visible sea horizon, and in the uncertain indications of the artificial horizon used as an alternative. It was a great help to both when a third method, radio navigation, became available. This method was increasingly used in the years between the wars and with a steadily growing accuracy. An early method for employment in aircraft was the use of large rotating coils, which could be oriented upon recognised radio beacon stations. In this way as many position lines could be plotted on the chart as there were suitably placed beacons available. Later, it became usual to call for the chart plotting to be done by land stations and for the pin-point position of the aircraft to be communicated to it by radio signal. This method achieved a well-deserved popularity.

During the Second World War extensive exploration into all forms of radio development took place, and many of these embodied the radio-pulse technique devised originally for research on the ionosphere and adapted later for the radio location of hostile aircraft,

with its well-known triumph in the "Battle of Britain." Radio location, or radar as it came to be called, gave the distance and bearing, as well as the approximate height, of approaching aircraft—it may be said in mathematical language to have given its answer in "polar-co-ordinates." At a later stage of the war, and largely as a result of work at the Telecommunications Research Establishment at Malvern, airborne radio instruments enabled the position of the aircraft which carried them to be plotted with facility on a "hyperbolic-grid" chart carried on the aircraft. This was found to be so remarkably accurate as to permit large targets to be successfully bombed by night or by day, even when a continuous cloud layer covered the ground. There were many other such applications tested and some of them employed, such as that for making a radio map of the ground or sea flown over, even when it was quite invisible to the eye. These applications had an obvious direct use in civil aviation, not only for navigation as such, but for the avoidance of collisions in the air, either with other aircraft or with dangerously turbulent clouds.

Indeed, one result of the war was to provide the civil air line navigator with such a wealth of choice as to be a positive embarrassment, especially as it was very desirable on the grounds of economy, as well as convenience, that on any international routes the systems to be used should be selected by the common assent of all the interests concerned. To clear the ground it was plainly necessary that there should be full and open conferences between the air line operators of the world. Such discussions took place and the most recent of them was that of the Special Radio Technical Division of the International Civil Aviation Organisation with its centre in Montreal. Its report of January last was briefly noticed in our issue of May 2nd. It shows that it was found possible to reduce considerably the number of alternative schemes which came up for consideration and so to clear the ground for the final selection (if one may use the word "final" for any air development) to be made as soon as the further essential exploratory work had been done into the technical and economic merits of each. Although useful agreement was reached on many points, the delegates did not see eye to eye on all of them. There were, for instance, two rivals for the shorter air routes in the "polar-co-ordinates" scheme favoured by U.S.A. and the "hyperbolic-grid" scheme favoured in this country. The former may be said to be the natural consequence of air route penetration of a sparsely occupied country and the latter of an air coverage plan natural to a country of earlier settlement and greater density of population. The last word here, as in other developments, must depend on a balance sheet of advantages and disadvantages technical and financial, yet to be made out. It is too early to say what the ultimate choice is likely to be in this as in other proposed schemes, but excellent preliminary work has been done and a real endeavour made to ensure that all air line navigators shall, so far as is possible and in increasing degree, work to a common end. In this field, as in so many others, great advantage can be gained by standardisation.

Literature

The Furness Railway: Its Rise and Development. By W. McGOWAN GRADON, B.A. 1946. Published by the Author, Corn Exchange, Manchester. Price 15s.

The North London Railway. By MICHAEL ROBBINS. Chislehurst: The Oakwood Press. Price 3s. 6d.

THESE two slim volumes appeared at the end of last year to celebrate the centenaries of two old and very well-known railways. But the second of the two is in fact a revised and third edition of a book that appeared first in 1937. It is a careful factual account with dates of the events in the life of this short line from its inception as a link between Camden Town and West India Docks, through its various accession and extensions and its absorption by the L.M.S. in 1923. There are a couple of maps and a number of half-tone illustrations.

The Furness Railway arose out of a scheme, advanced in 1843 by a Mr. John Abel Smith, for a causeway carrying a railway between Piel and Roa Island. This scheme was taken up by the Earl of Burlington, who saw the advantages of steam haulage of iron ore and slate from his mines and quarries. A company was formed and a larger scheme than Mr. Smith's was undertaken. The line was opened on August 12, 1846. It was intended primarily for mineral traffic and for fifty years passengers were not very well served. But in 1896 Mr. Alfred Aslett became general manager and the passenger traffic was nursed and encouraged. The Furness Railway, greatly enlarged by this time through amalgamation, lies on the fringe of the Lake District, and Mr. Aslett set about the building up of a tourist traffic by rail and coach. To that work he brought experience gained on the Cambrian and achieved notable success.

But possibly more than the tourist traffic for which it was famous the Furness Railway owed its success to the coming of Vickers to Barrow and to the works of the Barrow Hæmatite Steel Company. For a time the area was very prosperous, but as the mines in West Cumberland were worked out it fell upon evil days and parts of the territory of the once flourishing Furness Railway were scheduled as a "distressed area." By that time, however, the railway had passed into the hands of the L.M.S. Railway and the Furness Railway was no more than a memory.

Mr. Gradon deals very faithfully and thoroughly with the history of the line from its inception in 1846 till it lost its identity in the grouping of 1923. Like all British railways, the Furness grew up into a conglomeration by the incorporation of adjacent lines, notably the Whitehaven and Furness Junction and the Whitehaven, Cleator and Egremont railways, to each of which a special chapter is devoted.

To the locomotives of the company Mr. Gradon gives careful attention with many excellent "portraits." The "Copper Knobs" have, of course, pride of place, but many of the excellent engines built by Pettigrew are illustrated and, needless to say, Rutherford's famous "Jumbos" are not forgotten.

Mr. Gradon obviously writes of the Furness from his heart and with a local knowledge that leaves the reader who is not too well acquainted with the territory puzzled by some of the references. That is the only criticism we have to make of a volume that forms a valuable addition to British railway history.

SHORT NOTICES

Soft Water for Locomotive Boiler Feed. By B. D. Fox, M.I. Loco. E. London: Locomotive Publishing Company, Ltd., 88, Horseferry Road, S.W.1. Price 10s. net.—In his introduction the author of this book says: "Water treatment involves obscure chemical and electrophysical activities which are comprehensible only by trained chemists, . . . and so few locomotive engineers are adequately equipped for chemical warfare." It is pointed out that the aim of the book is to pilot the locomotive engineer clear of the pitfalls and complications of the ionic theory to a more intimate view of the major obstacles that have to be reduced, and a more confident prediction of the effects likely to be achieved by alternative methods of attack. The book deals first with the three disorders of locomotive boilers—scale, corrosion and priming and then puts forward six remedies. The third part of the book describes in some detail the application of the remedial measures. Based upon the practical experience of a locomotive engineer, this book is a valuable addition to the literature upon the subject of boiler water treatment in locomotives.

Philips' Resistance Welding Handbook. London: Philips Industrial (Philips Lamps, Ltd.). Price 10s. 6d. net.—This well-illustrated book is essentially a practical manual which should appeal to those engineers whose interest in resistance welding lies in its application to the general process of production. On the assumption that the reader is familiar with the principles of electricity and magnetism, and has a working knowledge of general engineering, the book avoids unnecessary technicalities and concentrates on the practical aspects of resistance welding. Separate chapters deal with spot, projection and gun welding; seam welding; flash and butt welding; the spot welding properties of rust-proofe mild steel sheet; and miscellaneous applications, including the spot welding of light alloys. Considerable attention is devoted to timers and to the use of electronic control devices. The book concludes with some useful information on production planning for resistance welding.

BOOKS RECEIVED

Steam Power Stations. Third edition. By Gustaf A. Gaffert. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, Aldwych, W.C.2. Price 27s. 6d.

Current Collecting Brushes in Electrical Machines By M. E. Hayes. London: Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, W.C.2. Price 21s.

Stainless and Heat-Resisting Steels. By Edwin Gregory and Eric N. Simons. London: Hutchinson and Company (Publishers), Ltd., 47, Princes Gate, S.W.7. 8s. 8d.

Explosion and Combustion Processes in Gases. By Wilhelm Jost. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, Aldwych, W.C.2. Price 37s. 6d.

Workshop Calculations for Machine Tool Operators. By G. Williams. London: Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, W.C.2. Price 10s. 6d.

Directory of Paper Makers. 1947 edition. London: H. F. and G. Witherby, Ltd., 5, Warwick Court, W.C.1. Price 10s. 6d.

Aluminium Alloy Castings. By E. Carrington. London: Charles Griffin and Co., Ltd., 42, Drury Lane, W.C.2. Price 25s.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

INSTITUTION AMALGAMATION

SIR,—Considerable correspondence has again been taking place in the technical press regarding possible fusion of the bodies now representing the engineering profession. It is, accordingly, of timely interest to note that the amalgamation of the Institution of Mechanical Engineers and the Institution of Automobile Engineers has in fact already taken place by making the latter an autonomous division of the former. Are there any reasons why the same procedure should not be carried to its logical conclusion?

No one will dispute that the Civils is the parent body from which others are descended and as a result that body should continue in its *rôle* as head of the family, not merely in name but in reality. The fifteen to twenty other engineering bodies requiring examination qualifications for membership should then become divisions of the Civils, but each would require to be completely self-governing.

The Council of the Institution of Civil Engineers would not be a body elected directly by members but would consist of the president and one vice-president for the time being of each of the divisional institutions weighted according to membership to allow larger divisions to have one or more extra council representatives. That council would then elect their own officers, provision being made in the constitution to ensure that the office of president would not be monopolised by any one division.

With regard to examinations, the common examination as at present with Section A would be set by the Institution of Civils and the final specialised examination by each of the divisions. The qualification of corporate membership, only to be obtained after the final examination had been passed, would then be A.M.I.C.E. (Mech.) or A.M.I.C.E. (Water), as the case may be. It would be open to anyone to qualify for as many divisions as he cared to by taking each final examination. Legislation could then be sought to "close" the profession.

Lastly, one subscription would be payable to the Institution of Civil Engineers, with a nominal maintenance fee for each division.

The above suggestions only represent the skeleton of a possible solution and will no doubt be disposed of by the critics as unworkable. This term can be applied to any proposal if the will to work it is absent.

ERIC W. DENHOLM.

Falkirk, May 22nd.

SIR,—I would suggest that the process of integration which is put forward in "Civil Engineer's" letter in your issue of May 16th, could be carried considerably further if it be the serious intention of professional engineers to align themselves in some association analogous to that which speaks for the medical profession.

Your correspondent advocates an amalgamation of the Institutions of Civil, Structural and Municipal Engineers and makes reference to the ignorance or misconception of the man in the street regarding what constitutes the practice of civil engineering; why the opinions of the ill-informed should be given such respect is not, however, explained.

"Civil Engineer" will doubtless recollect that the Institution of Civil Engineers exists "For the General Advancement of Mechanical Science," and that it was to this fundamental end that it was granted a Royal Charter.

There are no narrow bounds set here, no confinement of activities and interests to structures and municipal works; rather the founders of that Institution chose their words with care to make the proper ambit of the Institution's activities as comprehensive as possible. Subject to correction, I maintain that civil engineering still connotes all forms of engineering other than that which is strictly military or of a like nature.

In that doyen body to-day of our profession, therefore, already exists the centre round which amalgamations may take place, with affiliations between such groups and the centre. There are endless parallels and precedents in which component bodies retain a large measure of individuality, yet speak with one voice through a central organisation.

If professional engineers wish to canalise their power, which seems to be the only way, in these days, by which such results as an elevation of status relative to that of other professions and similar advantages can be gained, I submit that they should properly look for a lead to be given to their aspirations by the senior Institution.

CHRISTOPHER BELL.

Sidcup, Kent, May 22nd.

Education for Management*

THE committee wishes it to be clearly understood that there is no implication in this report that young men or women can be trained as managers in industry or commerce by following certain courses of study at technical or commercial colleges. Theoretical study alone cannot make a manager.

That action is necessary if multiplication of courses in management is not to dissipate national facilities which are already inadequate. So long as each professional institution requires its own syllabus in this field, this must create difficulties for the teaching institutions.

That the professional institutions should accept the obligation to include in their syllabuses as large a common management content as possible and confine specialised demands in this field to the essential minimum.

That courses leading to qualifications in management should be limited to two stages, namely, "Intermediate" and "Final."

That all management professional institutions should adopt a common curriculum for the intermediate course and that technical professional institutions should adapt any management requirements in their syllabuses to this common curriculum.

That the intermediate course should consist of three parts—an introduction to management, the "background" subjects and the "tool" subjects.

That there should be two types of final course, one for those who wish to qualify for management in some specialised field, the other for those who wish to qualify in general management.

That the curriculum for the final course in each specialised field should be prescribed in large part by the appropriate management professional institution and that the curriculum for the final course in general management should be prescribed by the appropriate national authority, but that final courses of both types should contain certain common elements.

That both intermediate and final courses should lead to qualifying examinations.

That all professional institutions concerned should consider whether the syllabuses given in Appendices B and C are acceptable *in broad outline* as a basis for the action recommended above.

That a student wishing to qualify in general management after qualifying in specialised management should do so only after an appropriate interval.

That students should not take a final Examination in specialised management before the age of 25, or in general management before the age of 28. Special arrangements should be made for the older student.

That students should not be expected to give more than 100 hours a year to formal part-time instruction at any stage of their courses. The possibility of granting day release should be considered.

That statistical information should be collected and published on the need for men trained in management and the educational facilities available. A number of agencies should collaborate in this work.

That immediate steps should be taken to secure an increase in the supply of trained teachers in management, both part-time and full-time.

That an advisory council on education for management should, from the outset, be associated with the proposed central institute of management.

That a commission of enquiry should visit the United States of America to investigate and to report on the facilities for education in management in that country as compared with those provided in Great Britain.

* Summary of Recommendations of a Special Committee appointed by the Minister for Education.

Extension of the Central Underground Line

IT is announced by London Transport and the Great Western Railway Company that a new railway, an extension of the Central Line Underground, having a length of 3¾ miles and serving the Acton, North Ealing, Perivale and Greenford districts, will be opened on Monday, June 30th. The new line branches off the Central Line at North Acton, and it has three new stations, Hangar Lane, Perivale and Greenford. It runs alongside the Great Western main line which has been specially widened, and as it is parallel to Western Avenue it will bring a frequent service to a large residential and factory area. There will be a train to Greenford from Leytonstone, Liverpool Street and the West End every six minutes in peak periods, every seven and a half minutes in the slack period, and every ten minutes in the evening. In all, 292 trains over the line will be run each day. Ealing Broadway, the present western terminus of the Central Line, will continue to be served by Central Line trains running through the West End and the East End, as hitherto. Special track features in the new extension include jointless rails in half-mile lengths, with expansion switches at the ends and modern signalling. For cold weather current rail baths for the automatic spreading of anti-freeze liquid are installed, and electrically heated points, as preventive measures against freezing. The Great Western Railway has been responsible for the widening of the track and the building of the stations, bridges, viaducts and signal cabins, while London Transport has equipped the line with permanent way, signalling and power supply and will operate the trains. With the opening of the new line the G.W.R. steam railcar service between Westbourne Park and Greenford will be discontinued, and the stations at Park Royal West, Brentham Halt and Perivale Halt closed. The extension of the Central Line to Greenford will be later continued further westward to Northolt and West Ruislip.

A BRITISH EXHIBITION IN COPENHAGEN.—Arrangements have been made, with the approval of the British and Danish Governments, to hold an All-British Exhibition in Copenhagen in September, 1948. The exhibition will be organised by the British Import Union of Copenhagen in collaboration with the Federation of British Industries, as was done in the case of the successful British Exhibition in Copenhagen in 1932. Steps to organise the exhibition are now being taken and, as soon as the necessary plans and other information for intending exhibitors are completed, a further announcement will be made.

The Iron and Steel Institute

No. II—(*Continued from page 447, May 23rd*)

FOLLOWING the symposium on the hardenability of steel, the Iron and Steel Institute continued its meetings at the Institution of Civil Engineers, Great George Street, Westminster, London, on Thursday, May 15th. Dr. C. H. Desch, F.R.S. (President) ,was in the chair.

The President made some announcements. Arrangements with the Iron and Steel Research Association had now been completed and the Research Committees of the Institute, which had been operating so successfully for some time, had been taken over by the Association. The Institute was to continue to undertake publications and to maintain an information service. The arrangement whereby Mr. Headlam-Morley, the Secretary of the Institute, was also Secretary of the Institute of Metals, had come to an end, as the Institute of Metals felt it should now have its own Secretary again. This change, however, would not make any difference to the general relations between the two Institutes.

The report and accounts were then adopted without discussion.

The President next presented the Bessemer Medal for 1947 to Sir William Larke, K.B.E., in recognition of his distinguished services in promoting research in the iron and steel industries.

Sir William Larke, expressing his appreciation of the award, told of the circumstances which brought about the establishment of the Iron and Steel Research Council, gave some details of the work that had been done and of problems still unsolved which the British Iron and Steel Research Association had now taken over. Finally, he said he only wished he were thirty years younger, for the immediate future of the iron and steel industries was so full of interest and possibilities.

It was announced that the date of the autumn meeting in London would be November 12th and 13th.

The reading and discussion of papers was then proceeded with.

The first paper to be read was by E. J. Vaughan and C. Whalley.

A New Scheme for the Microchemical Analysis of Ferrous Alloys

Synopsis

The paper describes the development of accurate microchemical methods of analysis for extremely small samples of steels and other ferrous alloys. Use is made of absorptiometric methods wherever possible to complete the determinations, and chemical separations are reduced to the absolute minimum. Precise conditions for the individual determinations of the elements carbon, silicon, phosphorus, sulphur, manganese, nickel, molybdenum, chromium, vanadium, cobalt, copper, tungsten, titanium, and iron are given in full, and by the application of these methods the analysis of most types of ferrous alloys can be carried out on a sample weight of 80mg. Many of the individual determinations are fitted together into composite schemes and the most comprehensive of these allows for the determination of all the above-mentioned elements with the exception of carbon, silicon, phosphorus and sulphur on a single sample weight of 15mg. These composite schemes of analysis are flexible and can readily be adjusted or simplified according to the nature of the alloy under consideration. Methods of obtaining samples in a satisfactory state of division and cleanliness, and the special small-scale apparatus used for performing the manipulations are described. Full details are given for the construction and operation of a small high-temperature micro-combustion furnace for use in the determination of carbon and sulphur. Typical results of the application of the methods to a wide variety of standard alloys by different analysts are given, together with results showing the speed of operation of the methods. Finally, a number of detailed metallurgical problems to which the new technique has been successfully applied are enumerated.

Discussion

The President (Dr. C. H. Desch, F.R.S.) said the methods described in the paper were extremely useful and delightful to work, and the results yielded a high degree of accuracy. The principal progress in this direction had been made in this country by British workers and the instruments used were essentially of British manufacture. The special spectrograph devices used were exported to other countries, where the method had been taken up. He added that the development of these methods had been very largely due to Mr. Vaughan and his colleagues.

Mr. G. Murfitt (William Jessop and Sons, Ltd., Sheffield) said that, whilst the authors had developed methods which almost anyone could use, it was not an easy matter to make use of a micro balance in a works laboratory because of trouble due to vibration. It would have made the paper more valuable if an idea of the time taken had been given. He believed fourteen hours was mentioned towards the end of the paper for the complete analysis of high-speed steel containing cobalt, but beyond that there was no mention of the time taken. These methods, of course, were not developed for works routine analyses, but applying these things to works routine methods he asked if the authors had come across the problem of segregation.

Mr. B. Bagshawe (Brown-Firth research laboratories) thought it an important omission that the paper did not cover aluminium nor carbon, for methods for determining the content of these elements in steel with great accuracy would be of considerable value.

Mr. Whalley, who replied to the discussion, said the accuracy of carbon determination had not been gone into in the paper. It depended on a variety of circumstances and was a matter for the future. The paper mentioned possible methods for zinc and lead, but they were not yet complete. In the same way, aluminium had not been included because, so far, a completely satisfactory method had not been found. He thought it would be possible to adapt the method in such a way that its accuracy would be of value in steelworks laboratory practice.

A discussion then took place on the following papers by H. Morrogh and W. J. Williams, and H. Morrogh, respectively:—

Graphite Formation in Cast Irons and in Nickel-Carbon and Cobalt-Carbon Alloys

Synopsis

An attempt has been made to give a concise statement of as many as possible of the features of graphite formation in cast irons which need explanation, together with a critical examination of the numerous theories which have been developed from time to time. A detailed description of the metallography of graphite in relation to its crystal structure is given, and the solidification of flake graphite-containing irons is described.

The process of under-cooling in cast irons is examined with reference to a number of problematical points and several new phenomena with respect to graphite formation in cast irons have been introduced. The effects of titanium and zirconium in refining the graphite depend upon the presence of the carbides of these elements. Two types of inverse chill have been demonstrated.

The process of graphite formation in nickel-carbon, nickel-iron-carbon and cobalt-carbon alloys has been studied, and the analogies between the mechanism of the process in these alloys with that in cast irons have been worked out. Under-cooling in all these alloys and in cast irons takes place by the solidification of a eutectic of solid solution+carbide, and the carbide phase decomposes after solidification. Coarse graphite structures solidify as a eutectic of solid solution+graphite. Nickel-carbon and cobalt-carbon alloys tend to give coarse graphite when they contain more than a certain amount of sulphur. In the absence of sulphur additions, spherulitic nodular graphite structures may be produced in nickel-carbon, nickel-rich nickel-iron-carbon and cobalt-carbon alloys by the addition of calcium and/or magnesium in a wide variety of forms. The manner in which these spherulites form has been studied.

The formation of spherulitic nodular graphite in cast irons without heat-treatment has been shown to occur. The conditions necessary for this have been outlined, and spherulites have been produced artificially without heat-treatment.

The undercooling of cast irons and of similar alloys has been discussed at length and the more general aspects of the particular type of undercooling have been emphasised.

A Note of the Mode of Occurrence of Tellurium in Cast Iron

Synopsis

The unique features of the influence of tellurium in cast iron have been emphasised. By metallographic means employing the polarising microscope it has been shown that in the presence of an excess of manganese over that required to neutralise the sulphur, tellurium forms manganese ditelluride. With no manganese or with insufficient manganese to balance the sulphur, iron monotelluride is formed. Various aggregates of manganese sulphide, manganese ditelluride, iron sulphide and iron telluride are described.

Discussion

Dr. J. E. Hurst (Bradley and Foster, Ltd.) said that his own knowledge of subsequent work by Mr. Morrogh and the results obtained made it difficult for him to be critical of the paper. Moreover, the results derived from the work were of very great industrial importance, and the results were likely to revolutionise the cast iron industry. Mr. Morrogh had been able to take this work so far as to be able to control the formation of graphite in cast iron under ordinary conditions of solidification and, within limits, to produce the spherulitic structure more or less at will. That was a very valuable discovery and it arose from the work that had been going on continuously at the laboratories of the British Cast Iron Research Association. The formation of an undercooled graphite in high-silicon irons was very important, and it had been studied very intensely in his own laboratories as well as by Mr. Morrogh. He took the view—and had already recorded it in a previous paper before the Institute—that a carbide, or a carbide-looking phase did exist in high-silicon iron alloys, alloys containing up to 17 or 18 per cent silicon. But he was satisfied that the carbide-looking phase was not what he was taught as Fe_3C. Its carbon content was substantially different and he was virtually satisfied that that carbide-looking phase also contained silicon. Further, he was almost satisfied that it contained as much silicon as there was in the matrix because of its corrosion-resisting properties. Therefore it was believed that the original carbide phase must have had silicon in it. Whether that was responsible for the carbide content or not he did not know, because the carbide phase in the high-silicon alloys might be a different carbide phase from the one that existed in ordinary grey iron. He hardly appreciated why Mr. Morrogh felt it necessary to add 0·4 per cent titanium to the 10 per cent silicon alloy to preserve the undercooled graphite. His experience was that titanium did not always do that, and he thought it rather served to demonstrate that there were other things present in Mr. Morrogh's case than silicon. He confirmed Mr. Morrogh's findings that soundness was

much better when associated with a fine graphite structure, but would go a step farther and point out that this might explain the soundness of castings made in permanent moulds. In this connection he had been investigating the gas content of cast iron and took the view that at least as far as centrifugal castings were concerned made in metal moulds, the gas content or absence of gas content was a factor that could not be neglected in considering the soundness of castings produced by that method. In the samples he had examined there was less hydrogen content in the centrifugal castings. Whether that was due to the centrifugal casting method alone or to the use of metal moulds or both, it was too early to say, but he wished to emphasise that in his view the gas content, and particularly the lower hydrogen content in a metal mould casting of that type must not be neglected in attempting to understand why such castings were generally sounder than others.

Mr. M. M. Hallett (Sheepbridge Centrifugal Castings, Ltd.) said that, whilst the ascicular eutectic structure might be, as the authors said, due to under-cooling of the white iron eutectic, he did not think there was sufficient evidence in the paper to prove it. Certainly the ascicular eutectic could be formed under conditions which seemed to preclude any possibility of under-cooling as in a centrifugal casting when there was appreciable turbulence.

Mr. E. Morgan (Stanton Ironworks, Ltd.) said his only real criticism was with reference to the work of Eash, and here he thought the authors had been far too modest when they said they had merely confirmed the findings of Eash. That investigator worked with a very large test bar—about 6in long and 1·2in diameter—cast in a cold mould, and he claimed to have been able to control the quenching temperature, &c., of such a large bar. He also picked out a very low-carbon iron which one would regard as having a very strong chilling tendency, but it was not possible to generalise from a limited type of experiment of that nature. The present authors had used a much more precise experimental method. As regards manganese as an inoculant, he pointed out that it had been said that it would dissolve carbon at high temperatures and precipitate it, on cooling, as graphite, and he thought that seemed to be a possible explanation of the inoculating value of manganese sulphide.

Mr. Morrogh, in reply, said that when Dr. Hurst spoke of the formation of carbides in silicon alloys, he was careful to say "carbide-looking phase." There was no doubt that there were two phases formed; that could be confirmed under the microscope. One phase was the normal Fe_3C, and as far as he had been able to ascertain, the silicon content of the carbide was generally the same as that of the matrix, up to about 7 per cent silicon. It seemed that the silicon replaced the carbon under those conditions. As to the formation of flake graphite, he had never been able to prove that this formed directly from the carbide, but the whole subject was a very complicated one. He emphasised that the presence of titanium or titanium oxide did not necessarily guarantee that an under-cooled graphite would be formed, but it was one of the conditions favourable to the formation of an under-cooled graphite.

The following paper by J. A. Hall and a Symposium on the "Contamination of Platinum Thermocouples," by the Liquid Steel Temperature Sub-Committee of the Alloy Steels Committee of the British Iron and Steel Research Association were then presented and discussed together at the afternoon session:—

A Photographic Investigation of the Brightness Temperatures of Liquid Steel Streams.

Synopsis

Cinematograph films have been taken of a range of steel streams from tapping and casting operations under such conditions as to enable an accurate density/temperature calibration of the film to be made, so that variations in brightness temperature of the steel surface can be investigated in relation to both time and space.

The effects of surface contamination and of the formation of partial black-body enclosures in the surface are discussed; the latter is found to be the most frequent cause of abnormally bright areas in the field of view. It is shown by laboratory experiment that an optical-pyrometer observer sighting on a flickering field or on the duller parts of a non-uniform field is likely to obtain a temperature value some 10 deg. Cent. higher than that corresponding to the mean brightness of the part of the field which is being observed. This figure is in general agreement with the results obtained on tapping streams. With casting streams, good agreement has been obtained between the optical-pyrometer reading and the average photographic value of the brightness of a selected spot on the stream over a period of about a second. Under these conditions, about five out of six optical readings lie within ± 20 deg. Cent. of the mean photographic value, while with tapping streams a similar proportion lies between 15 deg. Cent. below and 35 deg. Cent. above this figure.

It is shown that the use of a pyrometer employing a larger field of view than the normal disappearing filament pyrometer (such, for example, as a photo-cell pyrometer) is not likely to introduce very serious differences. The reading will tend to be higher than that of the optical pyrometer, but the difference does not normally exceed 5 deg. or 10 deg. Cent.

The variations in surface brightness have been explored by plotting frequency curves of the distribution of brightness from a large number of spots on a single frame. In this manner it has been found possible to isolate the brightness corresponding to a clear metal surface with considerable accuracy.

In the future programme of work it is proposed to take certain additional precautions which have already suggested themselves in order to secure higher accuracy (especially to secure greater uniformity of exposure between successive frames of the film) and then to use the frequency-curve technique in order to make emissivity determinations on a range of steels, the true temperatures being determined by the "temperature-ring" thermo-couple technique of Oliver and Land.

Discussion

Dr. Sven Fornander (Sweden) said that at the Surahammer Steelworks, Sweden, some experiments had recently been carried out which seemed to show that pyrometer design had an influence on the contamination of platinum thermocouples. The first series of experiments was made in a small high frequency induction furnace. A pyrometer as designed by Land was used. This type of pyrometer had a steel clutch mounting to fix the silica sheath in position, and it contained no parts that could give off gases when heated. It was found that up to eighty measurements could be made with this type of pyrometer with the same hot junction, without any measurable change in the E.M.F. The second series of measurements was made in open hearth and electric arc furnaces with another type of pyrometer with an uninsulated steel tube, a graphite end-block and asbestos string for fixing the silica sheath in position. After every tenth measurement, with the same hot junction, the pyrometer was calibrated against a standard pyrometer in a high frequency induction furnace and the pyrometer was found to read 10 deg. to 20 deg. low. This happened with every junction tested. The end-block was then made of steel instead of graphite, as described by Manterfield and Thurston before the Iron and Steel Institute in 1946, the silica sheaths still being fixed in position by asbestos string. After this change, the results were somewhat better, the change in E.M.F. being 8 deg. to 16 deg. after ten measurements with the same hot junction. The asbestos string for fixing the silica sheath was then replaced by steel wool. The result was a success in so far as up to fifty determinations could be made with the same hot junction without getting any measurable change in the E.M.F. The conclusion drawn from these experiments was that from a practical point of view it was essential that the pyrometer used should not contain any parts that were likely to give off gases when heated. Finally, he expressed appreciation of the Schofield-Grace device for measuring liquid steel temperatures, adding that it was felt in Sweden that this method filled one of the most urgent needs in steel-making and was a very useful tool for making high quality steels.

The authors replied briefly.

The Greater London Plan

The Ministry of Town and Country Planning published, on Tuesday last (H.M. Stationery Office, price 1s. 6d.), a memorandum which it has prepared on the Report of the Advisory Committee for London Regional Planning. It indicates that, in coming to his conclusions on the planning proposals for the region, the Minister has regarded as axiomatic the principle that wherever large-scale development is to take place, the aim will be to achieve satisfactory communities for work and living. There must, of course, be balanced provision for housing and industry, and the Minister has had regard also to the major new works required for proposed new towns and greatly expanded towns. There are approximately 150 local authorities in the area surveyed by the Advisory Committee, all of which have scrutinised the Report. The Government has accepted the proposal that the overall growth of London should be restrained and is in agreement with the scheme to preserve a green belt round London. Sir Patrick Abercrombie's plan of 1942 recommended the construction of new towns at Stapleford, Herts; Ongar and Margaretting, Essex; Crowhurst and Holmwood, Surrey; and White Waltham, Berks; but it has been decided not to proceed with these proposals on the grounds that the sites are too near existing towns or the land is too valuable to agriculture. Four new towns—Stevenage, Hemel Hempstead, Harlow and Crawley—have already been approved in principle and preliminary steps for their development are being taken. Consideration has been given to two further sites for new towns at Meopham, Kent, and Pitsea and Laindon, Essex, but at present the Minister reserves his decision regarding them. A proposal that an additional population of 167,000 should be dispersed in the green belt ring has not been accepted by the Minister, but recommendations are to be discussed with the various local authorities for the expansion of Newbury, Aylesbury, Bletchley, Chelmsford, Witham, Basingstoke and Ashford. Some expansion of Tonbridge, Horsham and Sawston is also proposed. The section of the memorandum dealing with industry explains that industry will need to be transferred from the congested parts of Inner London to the new towns and towns to be expanded in the outer areas.

Control of Bolts and Nuts.—The Minister of Supply has made the Control of Bolts, Nuts, Screws, Screw Studs, Washers and Rivets (No. 13 Order), 1947, which came into force on May 23, 1947. The Order amends maximum prices, the principal alterations being increases in price of the following steel products: bright steel bolts, nuts, screws, screw studs and washers; metal thread screws (rolled threads); socket set and cap screws; wood screws and mild steel rivets (under ¼in diameter). Price control of steel metal thread screws and nuts (turned threads) is removed by the Order.

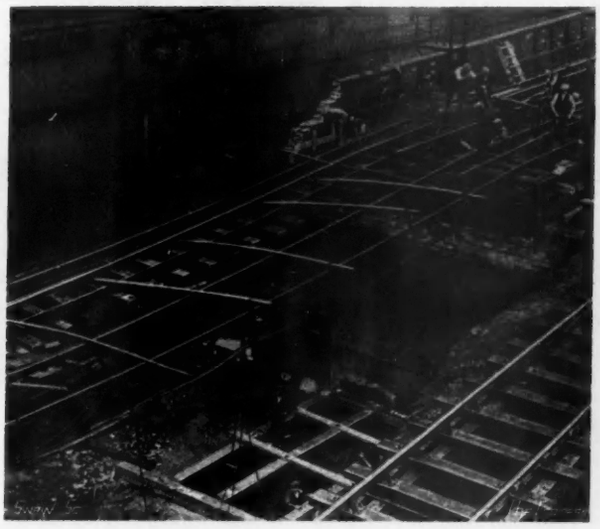
Restoration of L.P.T.B. Viaduct at Kilburn

A BRICK arch railway viaduct near Kilburn Station, London, N.W., which was badly damaged by enemy air action in 1940, has now been permanently restored without interruption to traffic on on the structure as temporarily repaired at that time. The temporary works which were briefly described in these columns in 1942*, have remained in service without undue maintenance for five and a half years.

At this point of the London Passenger Transport Board's system the down tracks of two lines, the Metropolitan and the Bakerloo, are on a brick arched viaduct, and the up tracks are on a parallel viaduct about 25ft to the north. The up and down tracks of the L.N.E.R. to and from Marylebone are on another viaduct closely adjoining to the south. On the night of September 15th-16th, 1940, a bomb penetrated the viaduct carrying the down tracks and, exploding below, made a big crater in approximately the centre of one arch. The resultant damage can be seen in the first photograph reproduced above. Three arches each 28ft clear span and one pier of the viaduct collapsed, leaving a gap of 85ft. Another pier was broken through near ground level and turned round, but remained standing. In addition to the down tracks being completely severed some damage was also done to the L.N.E.R. viaduct, but the viaduct carrying the up track of the L.P.T.B. escaped damage.

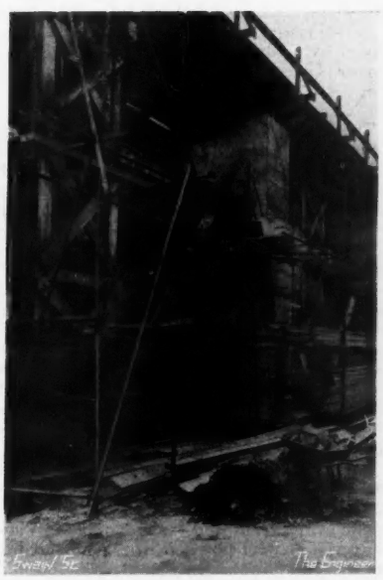
In order to restore a service as quickly as possible, the tracks on the up (or London) side of the damage were slewed over and connected to the up Bakerloo track. By using existing connections on the down side of the damage, the Metropolitan and the Bakerloo down trains were then run on the up Bakerloo track. The up Bakerloo trains shared the other up track with the Metropolitan trains. In this way a train service on one track in each direction was quickly provided past the demolished section of viaduct.

While this work was in progress the damaged pier was pulled over and work on clearing the site began; this involved the removal of some

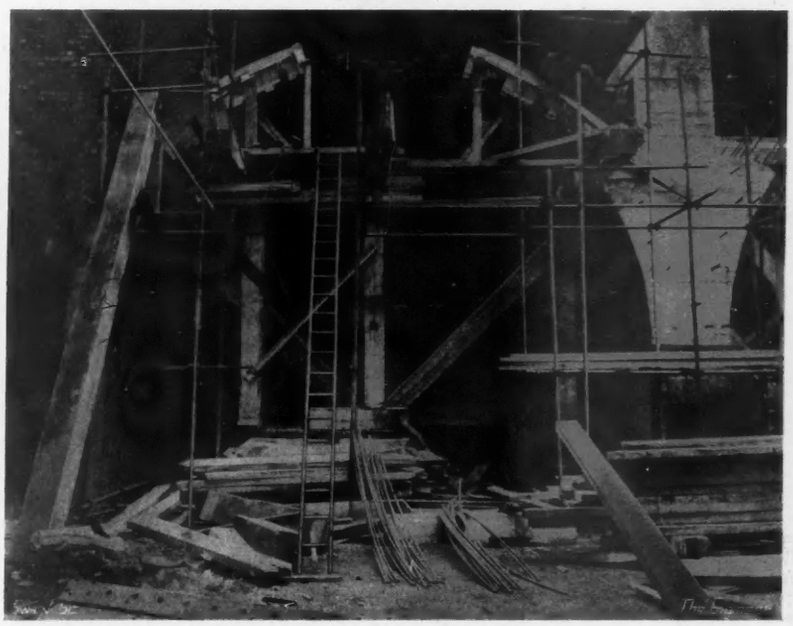


INITIAL STAGES OF TEMPORARY REPAIR

COMPLETION OF TEMPORARY REPAIRS



NEW CONCRETE PIERS



ARCHES IN COURSE OF CONSTRUCTION

* THE ENGINEER, March 20, 1942. "The Railways and Air Raids."

3500 cubic yards of rubble. At the same time three timber trestles were prepared and by September 24th their foundations were ready and trestle erection began. The damaged ends of the brickwork on each side of the gap were strutted and rolled steel joists of 24in by 7½in section were placed across the top of the trestles. On October 1st one track was placed in service and the next day—the sixteenth after the incident—both tracks were restored. The temporary works nearing the point of completion and with the train service restored can be seen in the second engraving.

Permanent restoration work on the viaduct was commenced in April, 1946. Owing to the difficulty in obtaining bricks, the new arches and the piers have been constructed in reinforced concrete, except for facing at the exposed ends. The spandrel walls and parapets have been built in brickwork to match the old work.

In the reconstruction two new piers were first built between the temporary trestles, which had been intentionally spaced to allow this. The piers were extended above the springing of the arches to the level of the underside of the temporary joists carrying the permanent way. Another illustration shows the piers at this stage of the work. The joists were then re-arranged to take their support from the new piers, and the timber trestles were removed to enable the arches to be turned without interruption to the train service overhead. Until all three new arches were constructed it was necessary to maintain the continuous longitudinal struts which had been incorporated in the temporary work, in order to take the unbalanced thrust of the undamaged parts of the viaduct.

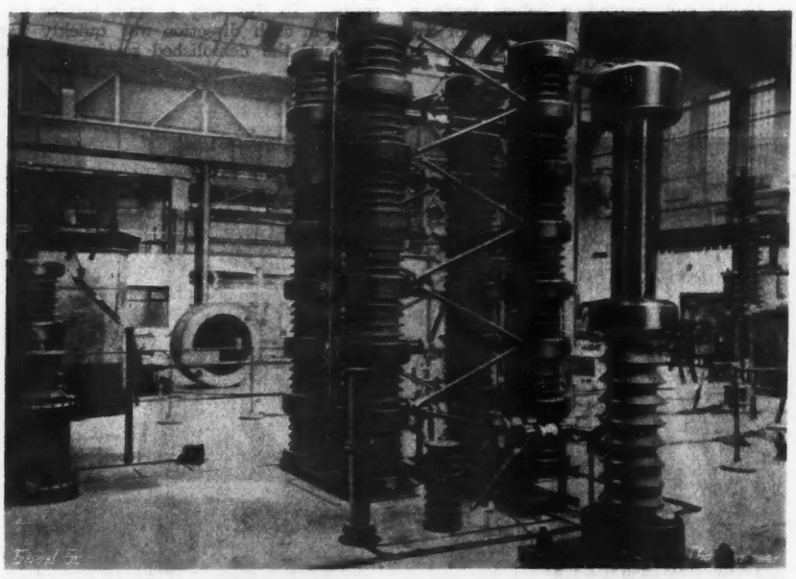
When the arches and spandrel walls were completed it was possible to remove the temporary joists, fill in with hardcore and ballast and restore the track during non-traffic hours.

H.V. Impulse Testing Plant

UNTIL recently power frequency characteristics formed the principal criteria for assessing the performance of high-voltage cables and accessories, but it is now well known that lightning conditions constitute a test that is perhaps even more searching. Underground cable systems are, in fact, by no means immune from the damaging effects of lightning, although their surge impedance is inherently lower than that of overhead lines. Lightning is an electrostatic phenomena involving the release of large amounts of energy in a very short time interval, from charged clouds, and its effects can be simulated in the laboratory by charging up high-voltage capacitors and rapidly discharging them to produce an energy impulse under controlled conditions.

Although the use of impulse plants developing extremely high-voltage surges of short duration is becoming increasingly and widely known for all classes of electrical equipment and for investigational work, it is believed that the plant described in this article is the first of its kind to be installed in this country expressly for high-voltage cable development work.

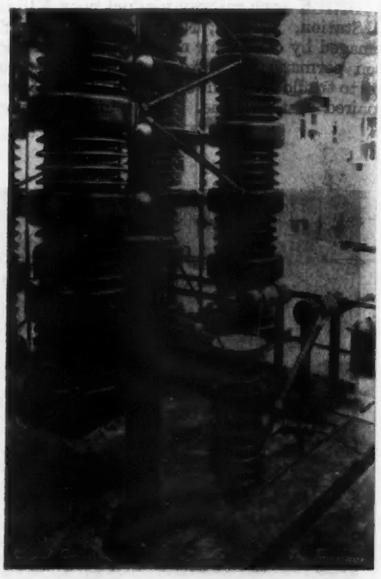
The impulse testing plant can be divided into four groups comprising: a 200-kV d.c. charging unit; an assembly of seven-stage condenser columns with the associated tripping mechanism; a capacitance potential divider for voltage measurement; and a high-speed continuously evacuated cathode ray oscillograph for surge recording. A general view of the plant is given in our first illustration, which shows on the extreme left the d.c. charging equipment; between the four condenser columns and the potential divider (which can be seen in the foreground to the right) is the tripping mechanism. Another illustration, reproduced herewith, shows the tripping mechanism in greater detail, while a third engraving gives a view of the control room showing the cathode ray oscillograph and the control desk.



GENERAL VIEW OF IMPULSE TESTING PLANT

For obtaining information on the behaviour of prototype cable systems under controlled impulse conditions a 1·2-MV impulse plant has now been installed as a planned addition to the power frequency test equipment that was installed in 1939 in the high-voltage laboratory of W. T. Henley's Telegraph Works Company, Ltd., at Gravesend. We were afforded the opportunity, recently, of inspecting the new impulse testing plant and of witnessing an interesting demonstration of its capabilities.

The charging unit of the impulse plant consists of a transformer and condenser and a rectifier bank. The incoming 50-cycle supply is fed through a 10-kVA, 0–250-V moving-coil regulator to the primary of the 6-kVA, 80-kV transformer, which is of novel design, inasmuch as the core operates at a potential half that of the output. The top plate of the transformer is connected to an oil-immersed porcelain-clad



CONTROLLED TRIPPING MECHANISM

0·015μF condenser rated at 100kV d.c. From this condenser the supply is taken through a resistance to the mid-point of a pair of oil-immersed porcelain-clad selenium rectifiers, each of which is rated at 200kV, reverse peak, and is capable of giving 5mA continuously or 20mA for one hour. The rectifier bank is isolated from earth by four pedestal insulators so that positive or negative d.c. can be obtained by connection to the top or bottom of the bank, the opposite end being earthed. The output from the charging unit is fed to the first stage of the condenser bank through a resistance. At the output side of this resistance contact is made to earth through a movable rod, which makes contact when the transformer is de-energised and is automatically disconnected by a copper disc motor when the transformer is energised.

CONDENSER BANK

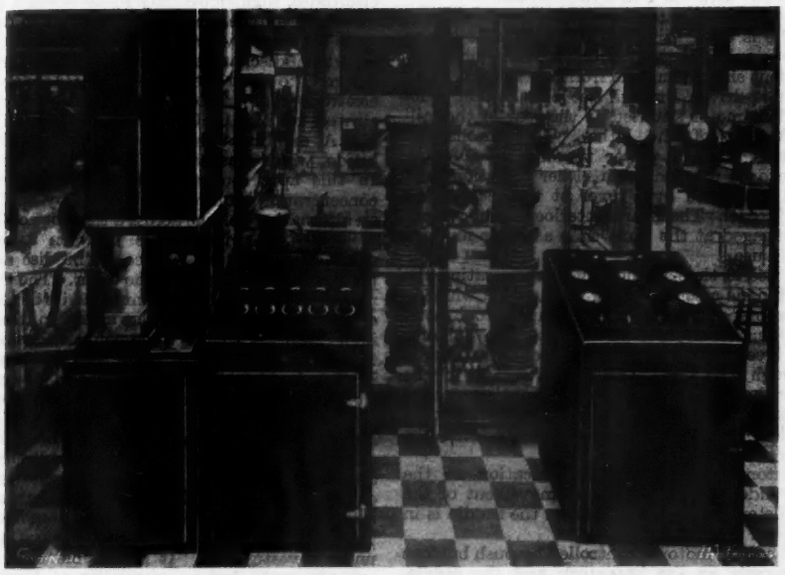
The main condenser bank consists of four columns, each made up of condenser units and insulating spacer members alternately. The front and back columns are identical and are permanently paralleled by the spark gap supports. Each condenser unit has a capacity of 0·0875μF and, since two units are permanently in parallel per stage, the stage capacity is 0·175μF. The total energy output with seven stages each energised at 167kV in series is 17kW-secs.

Charging of the seven stages is accomplished through a set of sloping resistors connecting the front columns and a similar set connecting the two back columns. The rear set of resistors, besides acting as charging resistances, also control the wave tail.

Discharging of the condenser bank takes place through hemispherical 150-mm gaps supported, one per stage, horizontally midway between the front and back columns. Viewed from the control position, the left-hand hemispheres can be set at any position required and then remain fixed. A ganged drive to the right-hand hemispheres provides adjustment for the gap setting. These hemispheres are connected by cam mechanisms through gearing to a vertical rod, which is made up of insulating members jointed in such a way as to allow a certain latitude in alignment. The rod is driven through gearing by a small motor at the base of the generator. This motor also operates

a Selsyn unit, which, with a similar unit on the control desk, provides for remote indication of the gap setting.

In the majority of the gap circuits small damping resistors are inserted, which also serve as part of the wave front control. Connection from the condenser bank to the sample is effected through a wire-wound resistor, which controls the wave front of the impulse.



CATHODE RAY OSCILLOGRAPH AND CONTROL DESK

CAPACITANCE POTENTIAL DIVIDER

The capacitance potential divider is made up of two high-voltage condenser units, each capable of withstanding 600kVp and having a capacitance of approximately 60 pf. These units in series form the high-voltage arm of the divider and are mounted on a steel base provided with rollers for mobility. In the base is mounted the low-voltage element of the divider, together with the recording cable matching resistor. Special care has been taken to ensure that the low-voltage capacitor is adequately screened and from this point the recording cable of low capacity is taken to the high-speed continuously evacuated cathode ray oscillograph by the most direct route.

TRIPPING MECHANISM

The tripping mechanism for the main condenser bank consists of two three-electrode gaps, two condensers with associated stabilising resistors and a tripping transformer. For convenience the common electrode is in two parts which are connected electrically, so that each three-electrode gap takes the physical form of a pair of two-electrode gaps in series.

All electrodes are mounted on insulating members on a welded channel iron base, and are driven by cam mechanisms ganged together to a motor-driven insulated shaft. The motor drive, together with a Selsyn unit for remote indication of the gap settings, is housed in a metal box. This drive is identical with that for the main gaps.

When energised, the tripping transformer injects a voltage of up to 30kV into the common electrode of the first two gaps, thereby initiating operation of the generator. The tripping transformer is specially designed to have a suitable wave form, and damping windings are incorporated to ensure that the injected voltage is not oscillatory. Two porcelain-clad condensers, mounted vertically, are connected across the two three-electrode gaps so that the potential of the various electrodes are maintained at the correct values for positive operation in sequence immediately the balance is upset by the injected voltage from the tripping transformer. To maintain the correct voltage ratio on the vertically mounted condensers two porcelain-clad resistors are connected across the combination. In the accompanying illustration the resistors can be seen on the left of the short condenser column. From the nearer hemisphere to the base of the lower condenser a tapped wire-wound resistor is connected, and from this resistor is taken the initiating cable for the cathode ray oscillograph.

In order to measure the voltage on the first stage use is made of the resistors which are connected in parallel with the condensers forming part of the tripping mechanisms. These resistors are oil-immersed, porcelain-clad, 100-kV units of 200 megohms each and together give a total of 400 megohms. The lower end of the two in series is connected to earth through a d.c. micro-ammeter calibrated to read mean kV and protected by the usual protective devices.

Since the impulse generator necessarily produces a unidirectional voltage of short duration by condenser discharge, efficient earthing is required to obviate extraneous discharges and to provide complete safety for operating personnel. In addition to the motor-operated automatic earth device referred to above, two earthing rods with insulated handles are provided for manual operation, which hook on to the spark gap supports on each side of the condenser bank.

CONTROL

The impulse generator is operated from a control pedestal situated in the control room overlooking the test floor.

As illustrated herewith, the control desk is provided with five indicating instruments, the left-hand pair giving the low-voltage input, the centre one reading mean stage kV and the right-hand pair, driven by Selsyns underneath, indicating the settings of the main and auxiliary gaps respectively. Below are the five sets of push buttons, operating the isolator, main contactor, moving-coil regulator and the two gap motors respectively. The push button in the centre is the final control which energises the tripping transformer and causes the generator to operate.

On the side of the cabinet is a Castell switch and a relay, which ensures that the plant cannot be energised unless the input switchgear cubicle and the control pedestal are closed and locked. Since the test area is served by an overhead crane an additional electrical interlock on the crane supply is fitted in the supply cubicle to de-energise the crane when nearing the impulse plant if the latter is in operation.

CATHODE RAY OSCILLOGRAPH

The high-speed cathode ray oscillograph, which was designed and manufactured in the Henley research laboratories, is situated in the control room on the left of the control desk. This instrument is of the continuously evacuated type employing a rotary backing pump and a mercury diffusion pump. The tube is fed from a 40-kV d.c. supply and is mounted on a cubicle containing the backing pump. The main tube, which is approximately 5ft long, consists of three sections: a discharge tube at the top fitted with pre-anode electro-magnetic concentration, a trapping chamber in the centre, to which is fitted the main concentrating coil, and a deflection chamber at the base containing the two pairs of plates and the recording mechanism at its base. The trapping and timing circuits are arranged on one side of the trapping chamber and the whole oscillograph tube is contained in an aluminium screen. Mu-metal screens are also inserted in the main oscillograph tube.

The controls are situated in an adjoining control cabinet, which also houses the power pack for supplying the timing circuits and for calibration purposes, and the oscillator for producing the timing oscillations. The waves from the impulse generator can be examined visually from two ports at right angles, and the fluor-

D.C. TRANSPORTABLE TESTING PLANT

escent screen can be moved for recording photographically either on plates or on films.

400-kV D.C. Testing Plant

Another equipment which enhances the test facilities of the firm's high-voltage laboratory is the recently completed 400-kV d.c. mobile testing plant. This test unit consists of an assembly of condensers, rectifiers, spacers and transformers, erected as four columns on a trailer which also houses the moving-coil regulator and the switchgear cubicle, as shown in the final engraving reproduced herewith. In the same way as for the impulse plant, energy is fed into the transformer stack, whence connection is made to a 200-kV condenser and then to four 200-kV metal rectifiers arranged in pairs. The output of this set is 5mA continuously, 20mA for one hour at 400kV; and 10mA continuously and 40mA for one hour at 200kV. This equipment permits of the continuous application of high-voltage d.c. to prototype systems and is simpler to operate than the normal type of rectifying valve testing equipment with associated filament transformers. The rectifiers, transformers and moving-coil regulator of the d.c. plant are interchangeable with the corresponding units on the impulse plant for obvious reasons. The d.c. plant is unique, in that it employs high-voltage oil-immersed metal rectifiers at the extreme operating voltage of 400kV.

The impulse generator and the 400-kV d.c. set were both manufactured by Ferranti, Ltd., who also assisted in installing the plant and in adapting it for cable testing purposes.

A 10½in Centre Lathe

The photograph which we reproduce below shows a new 10½in centre lathe now being produced by Darling and Sellers, Ltd., of Keighley, Yorks. This machine, which swings work up to 22in diameter over the bed and 15in diameter over the saddle, is designed to accommodate components up to 5ft 10in long between the centres.

It has an all-geared headstock and is driven by a reversible 12½ h.p. squirrel-cage motor, giving twelve spindle speeds, from 18 to 424 r.p.m. The front end of the spindle is bored to take a No. 5 Morse tapered centre and the hole bored through the length of the spindle is 3⅛in diameter. The front taper bearing of the spindle is lubricated by the "Hydrau-Portee" system of forced feed, and the gears within the headstock have cascade lubrication. Filtered oil for lubricating the gears is supplied by a pump set within the headstock casing and driven from the pulley shaft.

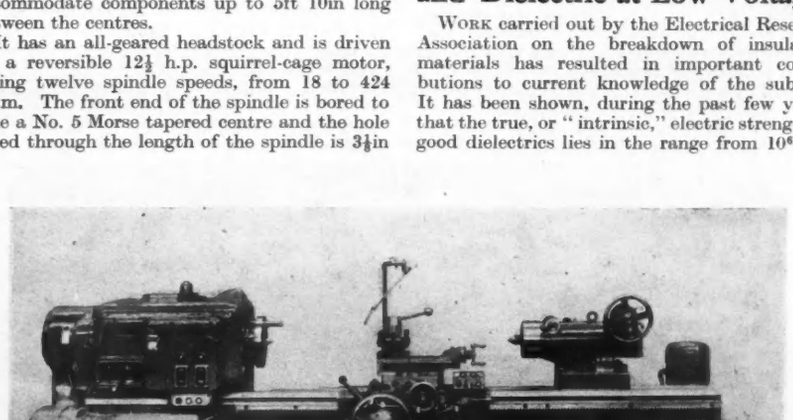
On the front of the bed, below the headstock, is a quick-change screw-cutting gearbox, which, with a ratio of 1 to 4, gives twenty-four pitch changes from three to forty-four threads per inch, and a similar number of feeds can be obtained without alteration of the change wheels. With the gearbox ratio altered to 1 to 1, the machine has twenty-four fractional pitch changes from $\frac{1}{28}$in to 1⅛in pitch. Through the gearbox the saddle has a range of sliding feeds from 0·002in to 0·033in per spindle revolution, and with a 1 to 1 ratio a feed range of 0·009in to 0·137in per revolution of the spindle. Surfacing speeds are from 0·001in to 0·016in per revolution and 0·0045in to 0·0685in with the 1 to 1 ratio in use.

A rapid power traversing mechanism for the saddle is driven through a friction unit in the apron, and this unit is driven from an independent shaft along the front of the bed. This shaft is driven through vee belts by an independent motor situated at the rear of the tailstock end of the lathe. This mechanism imparts a rapid power traverse of 20ft per minute to the saddle in either direction, and it is controlled by a lever at the rear of the hand wheel. The lever is interlocked and cannot be engaged at the same time as other motions are in use.

A useful time-saving factor in operating the machine is a self-indexing mechanism, which is incorporated in the square turret tool post. Indexing takes place when the tool post clamping lever is moved forwards and backwards through 120 deg. During movement of the lever the turret is unlocked, its locating plunger withdrawn, the turret is rotated to the next station, the plunger is re-located, and the turret re-locked.

Automatic forced feed lubrication of the bed slideways is effected by movement of the saddle and operates only when the saddle is in motion.

The main motor is controlled by push buttons on panels on the headstock and the saddle. These buttons start, stop, reverse, inch forward and inch reverse the motor, and an electric brake is provided to bring the spindle to rest quickly.



Centre Lathe

Discharges Between Electrode and Dielectric at Low Voltages

Work carried out by the Electrical Research Association on the breakdown of insulating materials has resulted in important contributions to current knowledge of the subject. It has been shown, during the past few years, that the true, or "intrinsic," electric strength of good dielectrics lies in the range from 10^6V to 10^7V per centimetre. The much lower values given by ordinary "electric strength" tests, or reached in industrial applications of dielectrics (values in the range of 10^5V to 10^6V per centimetre) are now known to result from the presence of ionic discharges at electrode edges, or in voids either within the material or between it and the electrodes. These discharges, even when so feeble that special apparatus is required for their detection,* attack the insulation and in time cause failure at stresses between one-tenth and one-hundredth of the intrinsic strength. To measure the intrinsic strength, which is independent of time, requires special techniques which entirely eliminate discharges from the highly stressed portions of the dielectric.

Under some conditions, as with very thin layers of material, or at sharp edges of thin electrodes, high stress may result from a quite low total voltage, and it is of interest to determine the lowest voltage, as distinct from stress, at which discharges may occur. Apparatus designed to show the existence of discharges at electrode edges at low voltages was demonstrated by Mr. C. G. Garton as part of the E.R.A. exhibit at the Physical Society's Exhibition, which was held in London last month. In this apparatus the intense electric stress concentration required is obtained by applying an alternating voltage across a thin disc of high-dielectric-constant ceramic between a needle point applied to one surface of the disc and a plane metallic coating on the other. The thickness of the disc is about 0·5mm and its dielectric constant about 1500. The stress in the air immediately adjacent to the point is thus many times greater than the value that would exist in the absence of the ceramic, and discharge from the point can be observed at voltages as low as 150V r.m.s. With a material of still higher dielectric constant a value of 120V is sufficient to produce a discharge. The discharges are quite microscopic, and give rise to no visible or audible effects. The transfer of charge per impulse is of the order of 10^{-13} coulombs only. The precise mechanism of the discharges is still under investigation. It is possible that they are not ionic, but represent, or at least are initiated by, cold electron emission from the point.

The detection apparatus consists essentially of a coil in series with the capacitor formed by the point-plane system, the high-frequency impulses developed across the coil when discharge occurs being applied to a high-pass filter followed by an amplifier and cathode ray oscilloscope. Any disturbance of the otherwise smooth oscillographic trace indicates the presence of discharges.

The results show that it will be necessary, in all accurate work on dielectric breakdown or loss angle, to consider the possible presence of discharges at any potential above 100V or 200V.

* Austen and Whitehead, *J.*, I.E.E., 88, Part II, April, 1941; Austen and Hackett, *J.*, I.E.E., 91, Part I, August, 1944.

International Shipping Federation Conference

It is announced that the International Shipping Federation will, on the invitation of the Swedish Shipowners' Association, hold its annual conference in Stockholm from Wednesday to Friday, June 11th to 13th. The Federation, we may recall, was founded in 1906, and its activities cover personnel questions and industrial relations in the shipping industry. The main items for discussion at the conference are the decisions taken at the Seattle conference in 1946, the agenda of the forthcoming meeting of the Joint Maritime Commission of the International Labour Organisation and the relationship of the Federation to the United Nations. The Stockholm conference will be attended by shipowners' representatives from Australia, Belgium, Canada, Denmark, Finland, France, Great Britain, Greece, Holland, India, New Zealand, Norway, Portugal, Sweden and the United States of America. The president of the Federation is Mr. Basil Sanderson (Great Britain) and the vice-president is Mr. Fr. Odfjell (Norway), while the general manager is Mr. Richard Snedden. The British delegates to the conference will be Mr. Basil Sanderson, Sir Arthur Sutherland, Bt., Mr. W. T. Gould, Mr. J. W. Duncan, Mr. R. J. E. Dodds and Mr. G. F. Penny. The Federation will be represented at the International Telecommunications Conference by Mr. H. W. Greany.

American Engineering News

American Steel Progress

The war expansion of electric furnace capacity in the United States to meet the great demand for alloy steels having now ceased, the excess capacity has stimulated activity in the melting and tapping of heat under an oxidising slag, in order to reduce the time required in operation of the slag-off, and the application of a reducing-slag. Semi-killed steels and rimmed steel of open-hearth quality are being made in electric furnaces. Experiments are being made with inert gas for flushing hydrogen from molten steel, and also with the drying of materials for charges in high-alloy heats as a means of lowering the hydrogen content of high-alloy and stainless steels. In open-hearth furnaces, the low-alloy, high-strength steels developed during the war obtained a heavy fraction of their alloy content from scrap. But current shortage of scrap is one of the problems in steel production. However, the war practices developed are likely to continue, since there is a continuing demand for low-alloy high-strength steel. Experiments are in progress with open-end immersion pyrometers, capable of obtaining a measurement of the temperature of the steel bath in a few seconds. Another line of experimentation is in measures of slag characteristics for use in establishing slag-control practice, but without any definite or marked results. In the basic process, slag-control methods are used largely as aids in controlling the phosphorus and sulphur contents of the bath, but appear to have little significance in establishing deoxidation practices. These latter are based mainly on carbon content, modified to some extent by slag conditions. This indicates the importance of more accurate carbon analysis of the bath. In several basic open-hearth furnaces, basic refractories have been installed at the ends for the purpose of reaching higher operating temperatures and lower costs for maintenance and rebuilding. Basic brick is also being tried for roofs. But it is uncertain whether reduced costs and increased production will offset the high cost of the basic brick. Commercially pure oxygen began to be used in steel furnaces in 1946.

Pulverised Coal for Rotary Kilns

In the use of rotary kilns for the manufacture of basic refractories for steel furnaces in the United States, solid fuels are pulverised largely on account of ease of control and rapidity of combustion. With pulverised coal the fuel supply can be varied by small increments and with very little time lag between the change of control and the resultant change in the flame. This feature is of great importance, owing to the narrow range of temperature for maturing the refractory clinker. By fine grinding the coal its rate of burning can be increased, thus liberating great quantities of heat within a small space in a short time. To attain temperatures of 2950 deg. to 3150 deg. Fah., as required for these refractories, it is necessary to liberate 125,000 B.Th.U. to 175,000 B.Th.U. per hour per cubic foot of the burning zone in the kiln. If the rate of flow through this zone is increased, the temperature must be increased to compensate for the shorter period of exposure to the flame. In the inclined cylindrical kiln revolving at ¾ r.p.m. per minute, raw refractory material is fed at the upper or chimney end, and gradually approaches the zone of highest temperature at the lower end where the fuel is introduced. The earlier practice was to store the pulverised coal until needed, but this was liable to result in dust explosions and irregularity of feed. Present practice is to store the raw coal and grind it as needed. Fineness of the coal is specified as 90 per cent passing a 200-mesh screen and no residue on a 48-mesh screen. The raw coal is of 13,800 B.Th.U. per pound, with 6 per cent maximum ash and 1 per cent maximum sulphur. Coal tar pitch has been used as fuel, but it is extremely friable and unpleasant to handle. From 30 to 40 per cent of the air for combustion enters with the stream of coal, the remainder being fed inside the kiln and being preheated by the hot refractory.

San Diego Aqueduct

Typical of conditions under which many cities of the United States are increasing their water supplies is the 80 mile aqueduct now being built to serve the city of San Diego, in California, and its surrounding area, including some smaller towns and irrigation districts. With a sudden great increase of population, due to war industries and local Army and Navy establishments, the existing water supply system became inadequate, but its source was already taxed to capacity. The difficulty was overcome by adoption of a project for a new and independent supply from the Colorado River. The aqueduct does not extend to the river itself, but taps an existing aqueduct of the Metropolitan Water District of Southern California. Of two routes surveyed, the one adopted has the advantage of only 5 miles of tunnels, with a maximum length of 1 mile, as against 7½ miles of tunnel on the alternative route. Headworks include a regulating reservoir at the connection with the Metropolitan aqueduct, and the water will be delivered to the San Vicente reservoir, about 10 miles from the city. The main line of the aqueduct consists of some 70 miles of reinforced concrete pipe of 4ft to 8ft in diameter, supplemented by 2 miles of 4ft steel pipe. The smaller sizes are used on steep slopes, the aqueduct lying across very rough country. Steel pipe is used where the head is greater than 500ft. There are numerous siphons, carrying the aqueduct under streams which cross its line, some of these siphons working under heads as high as 930ft. The concrete pipes have steel joints of the bell-and-spigot type, sealed with rubber gaskets and finished with cement mortar to give a smooth surface inside and outside. The steel pipes have welded telescopic joints, both pipe and joints having an interior coating of coal-tar enamel and an outside cover of cement mortar or gunite.

Handling Coal Mine Refuse

In the operation of the United States anthracite mines the economical handling and disposal of the waste material is an important problem, and a great variety of methods are employed, according to local conditions of topography and quantities. The materials include tunnel rock, mine rock, refuse from washeries and breakers, ashes and fine mine silt. Ashes and crushed rock or waste are sometimes flushed with water to fill old workings, but in general the material is finally deposited in great banks or in the filling of ravines, thus changing the local topography. In certain cases, the banks are worked over to reclaim waste coal. In volume, the refuse is from 20 per cent to 50 per cent of the total output of the individual mines. The methods and equipment for handling the material include mine cars, special refuse cars, trains of dump cars with steam, oil or electric locomotives, cable inclines with dump cars, belt conveyors, flight or chain conveyors, aerial tramways and motor lorries. Steam locomotives are of ordinary types, but the oil and electric machines may be independent of the cars or wagons or may be self-contained machines—" load-bearing locomotives "—carrying dumping or tipping bodies. Belt conveyors are 24in to 48in wide, operating on gradients up to 1 in 6 and at speeds up to 550ft per minute. Flight conveyors operate on gradients up to 1 in 3 and at speeds up to 150ft per minute. In one case an aerial cable tramway is used, 1650ft long, having 27 cars of 20 cubic feet capacity, moving at a speed of 400ft per minute. With standard gauge railway tracks, the cars may be of 40 cubic feet to 100 cubic feet capacity, usually with dumping or tipping bodies operated by pneumatic apparatus controlled from the locomotive. Other cars have fixed bodies and bottom doors. Trains have usually three or four cars, and one car has a spreader blade or bulldozer blade to level off the surface. A cable incline, operated by two cars of 250 cubic feet capacity, is 800ft long and on a slope of 22 degrees.

Regulating the Rio Grande

As the Rio Grande forms the boundary between the United States and Mexico for several hundred miles, it has long been a source of controversy, especially in the lower reaches, which are subject to heavy floods. Under a new treaty the problems are in the hands of an international commission, headed by two commissioners, representing the two countries. A system of flood-control works has been adopted, each country to carry out at its own expense the works within its own territory. The river channel is used as far as possible, and is supplemented on each side by floodways which are formed by levees or dykes, and carry excess flood waters to the Gulf of Mexico. Two, or perhaps three, main dams will form reservoirs serving for irrigation, municipal water supply, flood control and reduction, silt control, hydro-electric power development and the protection of water fowl. The first or lowest dam, to be completed by 1953, is to be about 75 miles downstream from the city of Laredo, Texas, and is to be an earth embankment about 4 miles long, including a concrete spillway section 625ft in length. Its maximum height will be 150ft above the river bed. The reservoir will have an area of some 95,000 acres when filled to flood level. The upper dam, 90 miles upstream from the town of Del Rio, Texas, is to be a concrete structure 420ft high and 200ft long. An intermediate dam may be built about 55 miles above Laredo and 50 miles below Eagle Pass. This would be an earth embankment 150ft high and 3 miles long, including a concrete spillway 800ft long. With the river flow regulated and its flood flows under control, large areas of land on both sides, now subject to overflow, will be available for irrigation and agricultural development. Power generation at the two main dams is estimated at 400,000,000 kWh. The treaty provides for the construction of any flood-control works approved and designed by the Commission, including the reconstruction of roads, bridges and railways, within the areas to be covered by the reservoirs.

Toll Roads in the United States

In the comprehensive policy and programme for highway development in the United States, a curious feature is a flood of projects for toll roads, although such roads are not favoured by either the Federal authorities or the highway departments of the several states ; nor by the various organisations operating bus and motor-truck lines. A 500 mile speedway from New York City to Buffalo, or Lake Erie, was planned as a toll road, but this plan was eventually abandoned. Under the highway laws, Federal funds are not to be provided as financial aid to toll road projects. But Bills are before Congress to authorise the building of six high-speed toll roads across the country, and to authorise the use of Federal funds in aid of their construction. Such roads cost more than ordinary expressways because of the special construction necessary for the collection of tolls, and the cost of collection is a continuing charge, which must be paid by the users of the roads. As to traffic, more than half of that on the system of main highways consists of short-distance travel, which would not be helped by toll roads having access points at long intervals. Few of the numerous projects now being put forward would be self-liquidating, and would thus permanently burden the travelling public, until such time as the latter forced a change. With toll bridges the case is somewhat different, as the law permits the use of Federal-aid funds. But there is the condition that the structure must be made free as soon as the financing bonds have been paid off. Some of the states highway departments have adopted the policy of purchasing private toll bridges and making them free. The demand for toll roads is based largely on political grounds. Few such public roads exist, but in all parts of the country there are projects for their construction, independent of but interfering with the network of official highways.

Industrial and Labour Notes

Control of Publicly Owned Industries

The Trades Union Congress has recently issued a pamphlet, entitled "What the T.U.C. is Doing," which is in the nature of an interim report of the present year's activities. One of the matters mentioned in the pamphlet is the control of publicly owned industries. The T.U.C. states that it has continued to keep in touch with the Government on the terms of measures for the nationalisation of certain industries, adding that, since the 1946 Congress attention has been concentrated on the Transport and Electricity Bills.

The T.U.C.'s main aim, the report continues, has been to see that the established negotiating machinery for wages and conditions is preserved or, where necessary, improved, and that adequate arrangements are made for consultation with, and representation of, the trade union movement in the running of those industries.

With regard to membership of control boards the T.U.C. says that it has received assurances, from the Government that, as in the case of the National Coal Board, it is intended to appoint to the Transport Commission and the Electricity Authority and to their subordinate bodies, persons with trade union experience. As to whether such appointments should be full-time or part-time, the T.U.C. thinks that a complete reliance on part-time appointments is unsatisfactory, both because less weight is thereby secured for the trade union viewpoint, and because a clash of responsibilities as between the union and the national board is likely to arise. The T.U.C. records that it has expressed this view to the Government and it believes that in all cases of substantial industries at least one person appointed for trade union experience will be a full-time member of the board concerned.

Attention has also been given by the T.U.C. to the arrangements proposed for consultation with unions on terms and conditions of employment, and it has been secured that whatever consultative bodies are set up, they shall not merely have power to discuss such matters as safety, health, welfare and organisation and conduct of operations, but power also to "promote and encourage" measures relating to these matters.

Coal Output and Consumption

Since the beginning of the five-day week in the British coal-mining industry, the Ministry of Fuel and Power has issued weekly production figures. The customary monthly statistics relating to coal production, consumption and also to manpower in the mines were published at the end of last week and relate mainly to the four-week period ended April 26th.

In that period, the average weekly production of mined coal was 3,488,900 tons and of opencast coal 183,200 tons. The weekly averages in the corresponding month of 1946 were 3,252,400 tons and 188,100 tons respectively. The total tonnage of mined coal lost during April averaged 395,200 tons weekly, recognised holidays accounting for a loss of 327,400 tons, disputes for a loss of 37,400 tons and accidents, breakdowns and repairs to machinery for a loss of 25,900 tons. The number of wage-earners on colliery books in April was 710,000, a figure which had been increased to 713,900 by May 10th, and the weekly average of shifts worked by all wage-earners on the colliery books in April was 4·79. The overall output per man-shift worked was 1·03 tons, another figure which by May 10th had increased to 1·07 tons. Voluntary absenteeism amongst coal face workers in April is estimated to have been 7·08 per cent, compared with 8·13 per cent in March and 9·07 per cent in April, 1946.

The total inland consumption of coal averaged 3,502,000 tons a week in April, and overseas shipments and bunkers accounted for 90,000 tons a week. Gas undertakings consumed 423,000 tons a week, electricity undertakings 503,000 tons and industrial consumers took 740,000 tons a week. A provisional figure for the week ended May 10th indicates that total inland consumption was then 3,506,000 tons. The total distributed stocks of coal on May 10th were estimated at 6,620,600 tons, compared with 6,925,500 tons on May 11, 1946.

The Confederation of Shipbuilding and Engineering Unions

The annual meeting of the Confederation of Shipbuilding and Engineering Unions was held last week in Dundee, and in the course of his Presidential Address, Mr. J. Willcocks expressed the view that at present the engineering and allied industries were not playing their full part in reconstruction. Mr. Willcocks would like to see a clear list of priority tasks, and suggested that it was not difficult to devise one for the engineering industry. "We know," he said, "that we need more coal-mining machinery, generating plant, railway equipment, textile and agricultural machinery and so on, and we want to see something like the wartime technique applied to gearing our industry to the job of tackling those priorities."

Mr. Willcocks went on to point out that only the Government could take decisions on these matters in the last analysis, but that did not mean that the engineering industry should fold its hands and wait until the Government did so. The Confederation's democratic district organisation, Mr. Willcocks thought, could be useful in this direction, for if production was to be guided into more essential channels then everyone concerned with production must take a hand. The flow of ideas, suggestions, complaints and, above all, constructive proposals would greatly help to impress on the responsible Ministers the need for action.

The Minister of Labour, Mr. George Isaacs, in an address to the delegates, condemned unofficial strikes. He said that there was not much in the complaint that the machinery of negotiation was too slow, and asserted that it was a mistake to try to put a time limit on a settlement. This country, Mr. Isaacs declared, had built up a trade union system which could not be beaten and industrial relationships that had no equal in the world.

Among the resolutions passed at the meeting was one calling for a new wages structure in the shipbuilding and engineering industries. Mr. Tanner, the president of the Amalgamated Engineering Union, in moving the resolution, said that the aim must be to try and get one national minimum rate for each of the three clearly defined grades, the craftsman, the machine operator and the labourer.

Output Per Man-Hour

Comment on the Government's call for increased production was made by Mr. J. D. Griffiths, the chairman, at the recent annual conference in Nottingham of the Association of Supervising Electrical Engineers. He said that, unquestionably, it was necessary to improve the present output per man-hour, although he felt certain that it could not apply to members of the Association who had reached the positions they now held, not by restrictive practices, but by their initiative and enterprise coupled with hard work.

It was now up to the supervisory grades, Mr. Griffiths urged, to show to those under them, by precept and example, the urgent needs of the moment. It would appear that such things as moral obligations had been forgotten in some quarters, where the motto seemed to be "How much can I get, and how little can I do?"

The R.A.F. and Trade Unions

By an agreement which has been made between the Air Ministry and the Amalgamated Engineering Union, certain ex-airmen who were serving in the Royal Air Force before September 3, 1939, will be regarded as fully skilled craftsmen and not as dilutees if employed under the Air Ministry in the appropriate civilian skilled engineering grades. The conditions are that they must have received engineering training in the R.A.F. and have completed five years' service as tradesmen. The Service trades named in the agreement are fitter, coppersmith and sheet metal worker, machine tool setter and operator, instrument repairer, grinder, miller and turner.

It should be noted that this agreement does not apply to the pre-war apprentice trained ex-airman, who is already recognised as a fully skilled engineering worker. Furthermore, it is additional to the agreements relating to the employment of certain "Hostilities only" ex-airmen by the Air Ministry and private industry.

Industry and Finance

Sir William Coates, deputy chairman of Imperial Chemical Industries, Ltd., addressed the National Union of Manufacturers on Wednesday of last week, and urged that the country should be told, not the bits and pieces, but the coherent whole of the Government's plan.

We should wish to know, he said, how the Government proposes to finance its capital activities, and how, in its eyes, industry should finance its own capital expenditure programme. Also, we needed the manpower budget, setting out in as much detail as possible the revised distribution that other elements in the plan required, and particulars of the parts that industry and Government needed respectively to play to effect any necessary changes. Progress reports at intervals should keep the nation informed of adjustments necessitated by unforeseen difficulties.

Sir William thought that it should be an essential part of any clear-cut general plan that Ministers and trade union leaders should ram home the fundamental fact that so long as we needed to save to make good our capital losses and improve our industrial equipment, we could not at one and the same time spend on consumption the money required for those purposes. Industry must reconcile itself to paying for its own capital expansion and re-equipment out of its own savings. That, no doubt, Sir William observed, was why we were urged to add to our reserves and were being stimulated to do so by a differential tax on dividends. Preaching to us on those lines, however, had to be reconciled with the Government policy of leaving wages to be settled by free and unfettered bargaining between employers and the trade unions concerned. When industry put more to reserve, it did so to pay for its capital programme, a programme that was in the interests of every worker, whatever his rank. It increased the volume of tools for his job and enlarged the opportunity and security for employment. If, however, Sir William declared, the phenomenon of growing reserves was merely to stimulate a claim on industry for their distribution in the form of higher wages, then not only was Government policy frustrated, but the inflationary potential which threatened at this moment would become even more dangerous.

Later in his address, Sir William referred to the responsibilities of management, saying that those who worked in industry could not be expected to spend their days poring over economic White Papers. Growth of knowledge and understanding must come largely through the spoken word or visual presentations. On employers there rested a duty to do their utmost to bring home to all associated with them, not only the objectives of their particular business and the ways and means by which management was seeking to attain them, but also the tasks which faced the nation as a whole and the inevitable consequences that flowed from given objectives.

French Engineering News

(From our French Correspondent)

PARIS, May 23rd

Following attacks made on Electricité de France and Gaz de France, due to a 36 milliard franc deficit, which will probably result in a 150 per cent increase in tariffs, defenders of the nationalised industries have hastened to explain the deficit. When Electricité de France and Gaz de France took over, they say, it was to find that the companies formerly supplying the country had left no credits, having distributed profits generously among shareholders, while leaving equipment in an obsolete and worn-out condition. In August, 1946, the International Economic Committee declared that an increase in tariffs would be necessary towards the end of the year. Renewal of material alone would require 3 milliard francs, while expenses incurred through the negligence of the former owners would bring the total to 4½ milliards. The tariff increase would therefore be about 56 per cent. Now the increase applied in January, 1947, was only 32 per cent and for this reason the company was bound to incur a deficit. Switching to the attack, protagonists of nationalisation are now asking that the money which should have been used to keep machinery reasonably up-to-date and which has been removed to Switzerland, should be returned by the former companies.

* * *

Britain was well represented at the Paris Fair. As usual, most British products were more or less hidden behind the names of their French agents. The Association of British Machine Tool Makers had a first-class stand and showed some interesting though by no means new machines. Unlike the French, Belgian and Czechoslovakian machines, the British exhibits still appeared to be wearing their wartime paint. They lacked finish, but this made little difference to orders. Mr. Rollo, who was in charge of the Association of British Machine Tool Makers' stand, told your correspondent that orders and inquiries had come from many different countries. He also said that many French buyers had such faith in British machines that they are willing to wait for them. The problem to-day is not whether manufacturers and constructors can deliver so much as if import licences can be obtained. Licences are being granted to all French firms engaged on the Monnet Plan. As 10 per cent of the proceeds of French exports can be used for imports, orders can be expected. Most British exhibitors agreed, however, that the time had come for a firm trade agreement with France, which would enable constructors to serve the French market to a far greater extent.

There was little novelty to be seen. French machine tool makers offered little that was new. The French aim this year is to show that France is more or less back to normal and able to produce good-quality machine tools.

The entry of Czechoslovakia into the machine tool field brought home to many British exhibitors the necessity of new trade agreements. Whereas before the war small countries imported most of their machine tools, even if they produced some for their own use, many of them are now preparing for exports.

Other sections of the Fair had little to offer in the way of heavy industry. America was almost alone in mechanical handling equipment. The electricity section was devoted almost entirely to domestic articles.

* * *

The strike at the Renault automobile plant continues with the workers demanding an increase of 10f. an hour, to bring their pay in line with that of metal workers, who recently received increases in the form of a bonus.

In the meantime, technicians of the Ministries of Industrial Production and National Economy have issued a communiqué stating that methods of increasing production at Renault are being studied, this being the only way in which a production bonus could be granted to the workers. The Executive Committee of the Metal Federation has nevertheless decided to agitate with a view to securing a bonus calculated on already increased productivity.

Notes and Memoranda

Rail and Road

STEEL WAGON PRODUCTION.—In a written reply to a House of Commons question, the Minister of Transport states that about 52,000 steel mineral wagons of 15 tons' capacity and over are at present in use. They represent 7·3 per cent of the total stock of mineral wagons. The present monthly rate of production is nearly 1700 and the anticipated output for 1947 is 26,000 wagons.

LIVERPOOL STREET STATION IMPROVEMENT.—An additional passageway is to be opened on Liverpool Street Central Line Station, giving easier access between the escalators and the westbound platform. This improvement has been undertaken to give better facilities for the greater number of people who are using the station now that the Central Line has been extended from Stratford to Leytonstone.

Air and Water

AUSTRALIAN CIVIL AVIATION.—It is reported that 1946 was the busiest year in the history of Australian civil aviation. During the year, 8,695,311 miles were flown and regular airlines carried 640,666 passengers. Passenger miles flown totalled 280,103,558, an increase of 45 per cent on the total for 1945.

THE "LLANDOVERY CASTLE."—The liner "Llandovery Castle" has now returned to the Union Castle's East African service, after extensive use as a hospital ship during the war. Reconditioning work has been carried out by Harland and Wolff, Ltd., and passenger and crew accommodation has been renewed. The liner has also been equipped to carry refrigerated and general cargo.

G.W.R. NEW CROSS-CHANNEL STEAMER.—The second of the two new Great Western Railway cross-Channel steamers was launched at Birkenhead on May 20th by Lady Portal, in the yards of Cammell Laird and Company Ltd., the builders. She was christened "St. Patrick," after the vessel of the same name which was bombed and sunk by enemy action in June, 1941. To mark the occasion and as a symbol of respect to the captain and crew who went down with the first "St. Patrick," she is to fly the battle-scarred pennant of her predecessor. The "St. Patrick" will have accommodation for 1300 passengers, 50 motor cars and 350 tons of freight, while sleeping quarters for 400 will be provided by single, double or open berths and luxury cabins. All modern aids to navigation are to be incorporated, including radar and echo-sounding devices.

CANADIAN COMMITTEE OF LLOYD'S REGISTER.—Lloyd's Register of Shipping has announced the establishment of a branch committee in Canada. The expansion of Canadian shipbuilding during the recent world war resulted in a great increase in the Society's activities there, and some 2,000,000 tons gross of merchant ships (77 per cent of the total) were completed to class with Lloyd's Register. The formation of the Canadian Committee will enable the principal maritime interests to be represented in the classification of Canadian vessels and will bring the Society's clients in Canada into close touch with its world-wide organisation. The new Committee is composed of leading representatives of shipowners, shipbuilders, engineers and marine underwriters in Canada, the Chairman being Mr. A. L. W. MacCallum, general manager of the Shipping Federation of Canada, Inc.

INTERNATIONAL AIR RALLY.—On Friday, June 20th, light aircraft from all over Europe will fly, *via* Lympne to Derby for an International Air Rally, which will be held at Derby airport on Saturday, June 21st. The rally has been organised by the Derby Aero Club along with the Derby Corporation and the Royal Aero Club of Great Britain, and the main object is to enable the pilots of the United Kingdom to return in some measure the hospitality extended so often to them on the Continent. Amongst several jet aircraft which will be included in the flying display will be a Gloster "Meteor V," a "Vampire II" powered with the Rolls-Royce "Nene" engine and the famous "Nene/Lancastrian," the world's first jet air liner. A "Meteor" powered with two Rolls-Royce "Trent" engines will also take part, and, as the first machine ever to fly powered by gas turbine engines driving propellers, it will be of particular interest. It is also the only machine which has yet flown powered solely by such engines. Small aircraft from the Continent will include a Bucker-Bestman and a Piper "Super-cruiser."

Miscellanea

METHODS OF CRACK DETECTION.—The Industrial Radiology Group of the Institute of Physics is arranging a symposium on "Methods of Crack Detection." The meeting will be held on Friday and Saturday, July 18th and 19th, at the Electric Lamp Manufacturers' Association, 2, Savoy Hill, W.C.2.

THE ALBERT MEDAL.—The Council of the Royal Society of Arts has unanimously decided to award the Albert Medal to Sir Robert Robinson, D.Sc., F.R.S., Waynflete Professor of Chemistry, in the University of Oxford, and President of the Royal Society, for his outstanding contributions to the advancement of organic chemistry.

TUNGSTEN ORES.—The Ministry of Supply announces that the present issue price of tungsten ores, 115s. per unit WO_3, has been withdrawn, and that any future sales from Ministry stocks will be made at prices which will be related to current market prices at the time of sale. Enquiries should be addressed to the Ministry of Supply (M.2), Shell Mex House, Strand, W.C.2.

ROOFING FELT INDUSTRY COMMITTEE.—The Roofing Felt Industry Executive Committee, which has operated since December, 1940, ceases to function on May 31st. It was appointed at the request of the Ministry of Works to exercise control of roofing felts and dampcourses. The control, it may be said, was a voluntary one and the efforts of the committee enabled all requirements for war purposes to be met promptly.

POLISH SCIENTIFIC AND TECHNICAL WORKERS.—There has recently been formed in Poland a united association of Polish scientific and technical workers, known as the General Federation of Engineering Associations in Poland. So far fifteen societies have been affiliated. All the societies have their separate legal status and organise their own branches whenever needed. Amongst the principles accepted as part of the new organisation's work is the development and control of the application of up-to-date scientific and technical knowledge.

HISTORIC PRESS WORKING IN AUSTRIA.—What is believed to have been the world's first steel press—built in 1861 by a Scottish engineer—is still working to-day in British occupied Styria, the centre of Austria's iron and steel industry. The press was constructed for the firm of Franz von Melnhof by John Haswell, a Scotsman from Lancefield, whose pattern was later copied throughout the world. Haswell studied at Glasgow University and later worked in several English machine tool factories. He went to Vienna in 1837 to join the firm of Mathias and Schroenerer, who had contracted to build Vienna's first railway station, and Haswell had charge of the job. A few years later he established the first Austrian locomotive factory.

BOILER AVAILABILITY.—The latest *Bulletin* issued by the Boiler Availability Committee, 14, Old Square, Lincoln's Inn, W.C.2, contains the seven papers read at the boiler availability session of the "Fuel and the Future" conference held in London last October. The subjects dealt with are "Boiler Availability from the Point of View of the Central Electricity Board," by Sir Johnstone Wright; "The Boiler Availability Committee's Recommendations to the Power Generation Industry," by Mr. M. H. Adams; "Methods of Cleaning Boilers," by Mr. W. G. Marskell; "Research Work on Boiler Deposits," by Mr. H. E. Crossley; "Researches at the British Coal Utilisation Research Association," by Mr. G. Whittingham; "Summary of Researches," by Mr. R. Ll. Rees; and "Boiler Design," by Mr. J. Mayer.

"ENTERPRISE SCOTLAND, 1947."—More than 500 firms, covering a wide range of industries, have expressed their intention of submitting goods for selection to the exhibition "Enterprise Scotland, 1947," which is to be held in Edinburgh from August 25th to September 30th. This response from Scottish industry has been forthcoming within a few weeks of the preliminary announcement about the display of Scottish industrial enterprise and design, and it is anticipated that before the selection closing date on June 2nd many more firms will announce their intention of co-operating with the Scottish Committee of the Council of Industrial Design to make the exhibition fully representative of every aspect of Scottish industry. "Scotland To-day" will be devoted to the products of Scottish industries. Shipbuilding will be displayed with models showing the development of the modern industry from Henry Bell's first steamship to a 22ft model of the "Queen Elizabeth."

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Chemical Society

Thursday, June 5th.—Burlington House, Piccadilly, W.1. "Substitution Reactions of Triphenylethylene and Related Compounds: a Contribution to the Problem of Synthetic Analogues of Progesterone," R. Royer and N. P. Buu-Hoi; and "Some Trinuclear Cyanine Dyes: Part I, The Synthesis of Neocyanines," Miss F. M. Hamer, R. J. Rathbone and Miss B. S. Winton. 7.30 p.m.

Institute of British Foundrymen

Tuesday to Friday, June 17th to 20th.—Annual Conference in Nottingham.

Institute of Economic Engineering

Sunday, June 8th.—Waldorf Hotel, W.C.2. "Factors Affecting Output per Man-Hour," E. H. Lewis. 2.30 p.m.
Friday, June 13th.—Cowdray Hall, W.1. "Research and Expansion in Industry," R. Cecil Smart. 7 p.m.

Institute of Physics

Friday and Saturday, July 18th and 19th.—INDUSTRIAL RADIOLOGY GROUP: Electric Lamp Manufacturers' Association, 2, Savoy Hill, W.C.2. A Symposium on "Methods of Crack Detection."

Institute of Welding

Tuesday to Friday, June 3rd to 6th.—North-East Coast meeting, Newcastle-on-Tyne.
Wednesday, June 25th.—Grosvenor House, Park Lane, W.1. Annual dinner. 7.15 p.m.

Institution of Civil Engineers

Tuesday, June 3rd—Airport Engineering Division: Great George Street, S.W.1. "An Outline of Methods of Air Navigation in the R.A.F.," S/Ldr. J. F. Davis 5.30 p.m.

Institution of Electrical Engineers

Saturday, June 21st.—S. MIDLAND CENTRE.—Visit to Meaford power station. 12.30 p.m.

Institution of Mechanical Engineers

Sunday to Friday, June 8th to 13th.—Centenary celebrations in London (see page 399), May 9th.

Institution of Mining Engineers

Wednesday to Friday, June 18th to 20th.—Summer meeting in Edinburgh.

Institution of Production Engineers

Saturday, May 31st.—YORKSHIRE GRADUATES: Visit to David Brown Tractors, Ltd., Meltham. 2.30 p.m.

Institution of the Rubber Industry

Friday, June 6th.—Connaught Rooms, Great Queen Street, W.C.2. "The Impact of Synthesis on the Rubber Industry," Dr. Philip Schidrowitz. 5.30 p.m.

Iron and Steel Institute

Thursday, June 26th.—4, Grosvenor Gardens, S.W.1. "The Effect of Different Methods of Pretreating Iron and Steel before Painting." F. Fancutt; and "The Protection of Iron and Steel by Metallic Coatings," J. C. Hudson and T. A. Banfield. 2.30 p.m.

Manchester Association of Engineers

Wednesday, June 4th.—Visit to the works of Rylands Brothers, Ltd., Battersby Lane, Warrington. 2 p.m.

Royal Institution of Chartered Surveyors

Monday, June 2nd.—12, Great George Street, S.W.1. Annual general meeting. 5 p.m.

Stephenson Locomotive Society

Saturday, May 31st.—Visit to Crewe Works and Sheds, L.M.S.R. 9.30 a.m. and 2.30 p.m.—Visit to Eastleigh Running Shed, S.R. 3.30 p.m.
Saturday, June 28th.—Visits to Brighton works, Redhill and Brighton running sheds, Southern Railway.
Friday, July 4th.—Visit to Swindon Works, G.W.R.

Women's Engineering Society

Saturday, June 14th.—Visit to the City and Guilds College, Exhibition Road, S.W.7. 2.30 p.m.

NATIONAL CERTIFICATES IN APPLIED PHYSICS.—The Institute of Physics has issued an illustrated booklet explaining to students, employers and senior executives concerned with the training of junior scientific staff the purpose, scope and value of the courses leading to the award of National Certificates in Applied Physics. These certificates are awarded jointly by the Ministry of Education and the Institute of Physics, and any college or works which feels that there is a local demand for a course may make application to the Ministry of Education for its recognition. Copies of the booklet may be obtained from the Institute of Physics, 47, Belgrave Square, S.W.1.

Personal and Business

MR. J. P. FITZGERALD has been appointed a director of the Zinc Corporation, Ltd.

SIR MILES THOMAS, M.I.Mech.E., has been elected President of the Society of Motor Manufacturers and Traders.

MR. P. H. WILSON, M.I.Mech.E., has been nominated President of the Institute of British Foundrymen.

MR. J. S. TRITTON has been elected President of the Institution of Locomotive Engineers in succession to Mr. F. S. Whalley.

MR. J. RUSSELL TAYLOR, chief engineer of the Igranic Electric Company, Ltd., has been elected a director of the company.

MR. T. W. ROYLE, a Vice-President of the London, Midland and Scottish Railway Company, has been elected President of the Institute of Transport for 1947–48.

MR. J. B. KERR, chief draughtsman, has been appointed general manager of the Wallsend Slipway and Engineering Company, Ltd., in succession to the late Sir Thomas McPherson.

MR. MARCUS GREENHORNE, A.M.Inst.C.E., has resigned his appointment as civil engineer to the Colne Valley Water Company, Watford, in order to take up work in the U.S.A.

SPEAR AND JACKSON, LTD., announces the following appointments: Mr. F. F. Gordon, managing director; Mr. G. F. Howard and Mr. G. W. Parsons, technical directors; and Mr. D. F. Gordon, special director.

THE NEWALL ENGINEERING COMPANY, LTD., has been granted a licence to manufacture and sell in the British Commonwealth the Oerlikon rigid radial precision boring machine, a product of Oerlikon Machine Tool Works, Zurich.

C. H. BLACKBURN AND CO., LTD., has opened a new factory at Calne, Wiltshire, for the manufacture of domestic electric appliances. Mr. B. C. Elliott has been appointed chief engineer, and Mr. A. P. F. Rogers works manager.

NEWALL-SENTINEL, LTD., is the title of a new company, with headquarters at Shrewsbury, which has been formed to handle the sales and distribution of the products of the Newall group of companies and the machine tool products of Sentinel (Shrewsbury), Ltd. The new company will also have showrooms at Peterborough.

TUBE INVESTMENTS, LTD., and HAWKER SIDDELEY AIRCRAFT, LTD., have agreed to merge their aluminium interests. For this purpose a holding company, in which each group will have an equal share and which will be jointly administered, is to be formed to take over the share capital of the subsidiary companies concerned of both groups. The companies involved in the arrangements are High-Duty Alloys, Ltd., the aluminium division of Tube Investments, Ltd., comprising the light alloy interests of Reynolds Tube Company, Ltd., and Reynolds Rolling Mills, Ltd.

Catalogues

PULSOMETER ENGINEERING COMPANY, Ltd., Nine Elms Ironworks, Reading.—Illustrated booklet on water purification plant.

RANSOMES AND RAPIER, Ltd., Waterside Works, Ipswich.—Publication No. 2/431, dealing with truck mixers and agitators.

HARLAND ENGINEERING COMPANY, Ltd., Harland House, 20, Park Street, W.1.—Publication dealing with submersible pumping units.

INDUSTIX, Ltd., 25, Walpole Street, S.W.3.—Catalogue dealing with permanent airtight plastic for boiler brickwork, flues, economisers, &c.

PROTOLITE, Ltd., Central House, Upper Woburn Place, W.C.1.—Leaflet No. P61, dealing with steady bushes for Swiss type automatics.

LEA RECORDER COMPANY, Ltd., Cornbrook Park Road, Manchester, 15.—Booklet No. M1A, dealing with the boiler feed vee notch meters.

C. A. PARSONS AND CO., Ltd., Heaton Works, Newcastle-on-Tyne, 6.—Publications on multi-cylinder turbines and single-cylinder turbines.

WESTINGHOUSE BRAKE AND SIGNAL COMPANY, Ltd., 82, York Way, King's Cross, N.1.—Publication dealing with coded continuous cab signalling.

GLACIER METAL COMPANY, Ltd., Alperton, Wembley, Middlesex.—Catalogue giving full details of the firm's extensive range of standard bearing products.

IMPERIAL CHEMICAL INDUSTRIES, Ltd., 42, Hertford Street, W.1.—Booklets on "Kutern" high-speed machining copper and "Kumium" high-conductivity copper-chromium alloy.

HENRY WIGGIN AND CO., Ltd., Wiggin Street, Birmingham, 16.—Publication giving details on the properties of the Wilco-Wiggin thermometals, and booklet on machining monel, nickel and inconel.

Reports on German and Japanese Industry

Limited numbers of copies of the reports of Intelligence Objectives Sub-Committees on German and Japanese Industry listed below can be obtained from H.M. Stationery Office at the prices stated.

No. of report.	Title.	Post free. s.	d.
F.I.A.T.:			
569	Manufacturing Bronze, Aluminium or Other Flake Metal Powders	5	2
605	Bussing-Nag Model LD 6 Diesel 100 h.p. Truck Engine	1	1
608	Oxidation of Methane to Formaldehyde: Interrogation of Dr. Karl Schmitt, of Bergwerke Gesellschaft, Hibernia, A.G., at Herne	0	7
838	Elemental Fluorine: I.G. Farbenindustrie, Leverkusen... ...	2	8
J.I.O.A.:			
43	German Mountain Engineer Equipment...	26	0
C.I.O.S.:			
XXXIII–21...	The Magnesium Alloy Industry of Eastern Germany	10	3
B.I.O.S.:			
266 (Appendix)	New Technical Applications of Acetylene	0	7
380	The Bentheim Gas Field (History and Present Status as a Source Natural Gas	2	1
446	Reitbrook Oilfield: Repressuring Using Flue Gas	2	1
513	Notes on the Organisation of the German Petroleum Industry During the War...	2	2
641	The German Machine Tool Industry: Includes Woodworking Machine Manufacture	35	8
659	Interview with Dr. Stocklin, formerly of the Leverkusen Laboratories of I.G. Farbenindustrie A.G.: Properties, Manufacture and Use of Buna Synthetic Rubbers, Latest Developments	0	7
727	Manufacture of Anti-Fouling Paints in Germany and Related Matters	9	3
786	Investigation of Methods of Development and Evaluation of New Plastic Products in Certain German Establishments	4	2
814	A Survey of the German Pile Fabric Industry...	5	2
840	German Brush Machine Design and Manufacture	3	8
867	Television Development and Application in Germany	7	3
888	Gun Boring	5	9
917	German Roads and Soil Stabilisation	6	2
918	Report on an Inspection of the German Road System: 1945 ...	3	2
919	The Application of Electrosmosis to Soil Drainage on Civil Engineering Work in Germany ...	1	7
922	Tatra Car, Type 87, V-8 Air-cooled Engine at Rear	4	8
979	German Button Industry	6	8
980	Electro-Acoustics in Germany: Part I	4	8
993	Notes on Production of Cast and Sintered Alnico Magnets	3	2
1004	X-Ray Crystallography in Germany and Austria, with Special Reference to Mineralogy	3	2

B.I.O.S. Information Section, 37, Bryanston Square, W.1., which has at its disposal a considerable volume of information not in a form suitable for general reproduction, is prepared to receive enquiries regarding all problems relating to scientific and technical intelligence on both German and Japanese industry.

Launches and Trial Trips

LEINSTER, cross-channel passenger vessel; built by Harland and Wolff, Ltd., for the British and Irish Steam Packet Company; length 367ft, breadth 50ft, depth 19ft, gross tonnage 4000. Engines, two-trunk, two-cycle, airless injection, Harland-B. & W. diesel, cylinders 500-mm bore by 900-mm stroke. Launch, May 20th.

CITY OF JOHANNESBURG, twin-screw motor vessel; built by Barclay, Curle and Co., Ltd., for the Ellerman Lines, Ltd.; length 497ft, breadth 64ft, depth 36ft 6in, 10,500 tons deadweight. Engines, Barclay-Curle-Doxford opposed-piston, cylinders 670-mm bore by 2320-mm combined stroke. Launch May 23rd.

AURIS, single-screw tanker; built by R. and W. Hawthorn, Leslie and Co., Ltd., for the Anglo-Saxon Petroleum Company, Ltd.; length 482ft 6in, breadth 59ft, depth 34ft 10in, 12,000 tons deadweight. Engines, Hawthorn-Sulzer diesel of the latest four-stroke cycle trunk piston type, with eight cylinders developing 1100 b.h.p. at 375 r.p.m. Launch, May 19th.

A Seven-Day Journal

Materials and Supplies for the Fuel Industries

THE Electricity Commissioners announce that it has been decided that the authorisation or the issuing of licences to acquire controlled materials and supplies for all the fuel industries, and all priority questions relating thereto, shall be concentrated into one organisation. From Monday, June 2, 1947, the Ministry of Fuel and Power will be the responsible Department in respect of the requirements of the electricity supply industry in such matters. The arrangement will apply to all materials such as iron and steel, including broad railway track, and timber, including wooden poles for overhead lines, for which a formal authorisation or licence is required, before they can be acquired or used; other materials such as lead or copper, not requiring formal authorisation of licence, but in respect of which difficulties may arise owing to their being in short supply; items within the scope of the Materials Priority Scheme referred to in the Commissioners' circular letter of May 17, 1946, and miscellaneous items for which coupons or certificates are required, such as protective clothing, towels, industrial gloves, thigh boots, gum boots and cotton. As from Monday, June 2nd, all enquiries by electricity undertakers in respect of such materials and supplies should be addressed to the Director, Priority and Materials Branch, the Ministry of Fuel and Power, 7, Millbank, London, S.W.1. Applications already made to the Commissioners will, as far as possible, be dealt with up to June 2nd, and thereafter they will be issued on behalf of the Minister of Fuel and Power and no renewed application to the Minister need be made. The Electricity Commissioners will continue to be responsible for the authorisation of any building or civil engineering works for which any of the controlled materials may be required and applications for authorisation of such works under Regulation 56 A of the Defence (General) Regulations should continue to be addressed to them.

The Cotton Textile Machinery Industry

THE Cotton Industry Working Party's report, published last year, recommended that a committee should investigate the manufacture and supply of textile machinery to the cotton industry. Such a committee was subsequently set up by the Minister of Supply, with Mr. Justice Evershed as its chairman, and it has now presented an interim report, which was published at the end of last week by H.M. Stationery Office. The report relates to investigations into the affairs of Textile Machinery Makers, Ltd., which is chiefly responsible for the manufacture in this country of machinery for cotton spinning and preparatory processes. The committee expresses its appreciation of the readiness with which the company responded to its recommendations, although it deplores the lack of confidence which appears to exist between Textile Machinery Makers, Ltd., and its actual and potential customers. The report very properly points out that, without that confidence, the production of machines and the consequent re-equipment of the cotton spinning industry "cannot be soonest and best achieved." It emphasises that between 1938 and 1945 the cotton machinery industry was substantially turned over to the production of munitions, so that it had no opportunity to develop its technique. At the same time, the committee feels that when the industry was turned back from war to peace production in 1945, it was in certain aspects deficient and fell short of the standard to be expected of an industry of such national importance and potentialities. Amongst the criticisms made of the industry—that is, of Textile Machinery Makers, Ltd.—are that, in the matter of research and technical development, it has been deficient, and that it has failed to comply with modern standards of costing. Undertakings on these and other matters raised have been given by the company, and, bearing in mind that the urgent need of the moment is production, the committee's opinion is that it is more likely to be obtained immediately if there is the minimum of disturbance of the existing organisations.

Liaison Between Planning and Land Drainage Authorities

IN a circular sent to planning authorities, county councils and joint town and county planning committees, in England and Wales, the Minister of Town and Country Planning, stresses the importance of maintaining the closest liaison with local drainage authorities, not only from the point of view of land drainage, but also in the interests of planning itself. In certain cases development in lowland areas or near watercourses may, it is stated, lead to flooding, and thereby cause much damage to property which may be costly and difficult to remedy. On the other hand, drainage authorities may have plans for improvements in drainage, including the provision of new cuts, or by-pass channels which would be seriously prejudiced by development. A copy of this circular is also being sent by the Minister of Agriculture and Fisheries to all drainage authorities, asking them to give to planning authorities all the advice they can, on the implications, from the point of view of drainage, of any specific planning proposals, and any information about long-term drainage projects which may affect them. The circular includes a note on land drainage considerations, which sets out for the guidance of planning authorities the various ways in which development may affect land drainage. This note deals with river improvement and control, and road improvements in connection with new estates involving the construction of new bridges or culverts across water courses. The laying of sewage and water pipes, so as not to obstruct the flow of watercourses or their improvement, provisions for swimming pools and bathing places, the building and planting of embankments for the protection of sites from tidal inundation, and the silting effect of trade effluent containing sediment and slurry from gravel workings, are also dealt with.

The Teaching of Statistics

IN 1944 the Council of the Royal Statistical Society, in view of the growing recognition of the importance of statistics in Government work, commerce and industry, and in scientific research, appointed a committee under the chairmanship of Professor E. S. Pearson, to enquire and report on the teaching of statistics in the universities. That report has now been considered by the Council and has been published, price 6d., in advance of the Society's *Journal*. After stressing the importance of statistics, the need for training in statistics as ancillary to other subjects is mentioned, and a more widespread knowledge of the statistical approach is emphasised together with the need for schools of pure statistical teaching and research. Three types of university courses are laid down, elementary courses, ancillary courses, and advanced courses, while it is stated that courses for extra-mural students are needed in universities, to give training to thousands of persons who have passed the university stage, and are now at work without having received any training in statistics. The Royal Statistical Society has recently authorised its council to hold examinations for testing the statistical proficiency of such Fellows of the Society who desire to submit themselves for examination, and the hope is expressed that all universities giving special courses will examine and will give diplomas. A final section of the report deals with various matters in the organisation of the teaching of statistics in universities, and the provision for practical work, including statistical laboratories with computing machines.

Diesel Engine Users' Association Summer Visit

OVER 100 members and guests of the Diesel Engine Users' Association took part in the summer visit, on Friday last, May 30th, to the Thames Haven works of the London and Thames Haven Oil Wharves, Ltd. The party left Westminster Pier at 11 a.m. in the Thames steamer "Ich Dien," and luncheon was served during the voyage. The private jetty was reached at Thames Haven shortly after 2 p.m., and the party disembarked and inspected some of the pumping plants and the oil tank installation, also the power-house of the company. The President of the Association, Mr. C. Green, A.M.I. Mech. E., F.G.S., and the Committee, led the party, and it was welcomed at Thames Haven by Mr. A. E. Sawdy, the managing director, Mr. A. Smith, the works superintendent, and Mr. G. W. Gooden, the electrical engineer of the London and Thames Haven Oil Wharves, Ltd. The power-house, which supplies all the current needed by the installation, was laid down about 1927, and the first generating sets to be installed were three six-cylinder, Vickers-Petters, crankcase compression, two-stroke engines, direct-coupled to 350-kW d.c. generators, running at 300 r.p.m. In 1938 two further Crossley engines were added, each of the mechanical injection four-stroke type, with six cylinders rated at 600 b.h.p. when running at 375 r.p.m. They are direct-coupled to 350-kW d.c. generators. All the generators and switchgear were supplied by the Electric Construction Company, Ltd., of Wolverhampton. The engine circulating water is cooled in Heenan and Froude coolers, and we noted that a Spanner thimble-tube waste heat boiler is installed to recover the heat of the exhaust gases and raise steam at a pressure of 60 lb per square inch.

Research and Development on Springs

THE Coil Spring Federation was formed in 1942 as a wartime measure, and a research organisation came into operation in October, 1945. The research and development scheme up to the present provides for extra-mural researches to be carried out by post-graduate assistants at universities, and it represents the first step towards establishing a central research organisation with facilities adequate to maintain the highest possible technical standard. Two researches, one on spring steels, and the other on the effects of surface protection on the fatigue behaviour of springs, are in progress at Sheffield and Birmingham, and a third research on the relevant properties of cold drawn spring wire is being arranged. The research work is directed by the Research Consultant and is administered as a whole by the technical committee of the Federation. A further activity of the research organisation is the publication of the Coil Spring Federation *Bulletin*, which contains results of investigations, with other articles and information of technical value. The research organisation has received the approval and support of the Department of Scientific and Industrial Research, and contributions from any industrial firm is grant earning. It is felt by the Federation that the results of its research work will not only be of value to spring makers but will be of considerable interest to users of springs and the makers of spring materials. Arrangements have accordingly been made for firms who are not spring manufacturers, to become associate members of the Federation's research organisation and to participate in its results. The Federation welcomes the co-operation of firms, who should apply to the Secretaries of the Coil Spring Federation (Heavy Section), Peat, Marwick, Mitchell and Co., 301, Glossop Road, Sheffield.

A Laboratory Testing Machine for Helical Gear Tooth Action

By HARRY WALKER, Ph.D.

IN a previous article* the author suggested a form of rotary testing machine for the purpose of carrying out on simple test pieces load tests, the results of which can be related directly to the teeth of helical gears to which the test pieces correspond. Such a machine has now been constructed and a description of it is given below, together with the results of a few preliminary tests.

A feature of the machine was to simulate the action of helical teeth on simple test pieces and so obviate the necessity of using actual gears for test purposes.

The principle of the machine will be described by reference to Fig. 2. View 1 is a section of a pair of helical gears taken normal to their axes. In this view the zone of contact is a plane at right angles to the paper, represented by the line *ad*. The plan of the zone of contact is a rectangle, as shown in view 2, and this contains lines of contact such as AB, which are inclined at the base spiral angle σ_o. At any point of contact, such as M_1 in view 1, the physical conditions are completely defined by the two following clauses :—

(1) The instantaneous radii of curvature of the two contacting involute profiles of the wheel and pinion are equal to I_1M_1 and I_2M_1 respectively, the points I_1 and I_2 being the fixed interference points.

(2) The instantaneous rolling velocities at M_1 on the profiles of the wheel and pinion are in opposite directions and are proportional to the distances from M_1 to the fixed points I_1 and I_2. They are actually equal to $2\pi N$ (I_1M_1) and $2\pi n$ (I_2M_1), where N and n are the rotational speeds of the wheel and pinion respectively.

Thus in view 2, if we consider any point M_2 on the line of contact AB, and draw a line Q_1Q_2 normal to the axes to meet parallel lines through I_1 and I_2 at Q_1 and Q_2, the conditions at the point M_2 are that the instantaneous radii of curvature of the wheel and pinion tooth are Q_1M_2 and Q_2M_2 respectively, and the rolling velocities on the wheel and pinion profiles are respectively proportional to the distances Q_1M_2 and Q_2M_2.

These conditions are fulfilled by the surfaces of the frustra of two cones, as shown in view 3, making contact along a line A_3B_3. The cones each have an included angle equal to twice the base spiral angle σ_o and their axes are at a distance apart equal to I_1I_2. If they are revolved in opposite directions at speeds equal to the respective gear speeds their conditions as regards relative curvature and rolling and sliding velocities at all points along the line A_3B_3 will be identical with the conditions which appertain to the actual gear teeth making contact on the line AB.

In practice, the cones can be driven at the required speeds by connecting them with spur gears of the same ratio as the helical gears. The speeds of the connecting gears should be equal to the respective speeds of the helical gears that the cones are intended to simulate. When so engaged and run, there will be a plane P_3P_3 in which pure rolling, without sliding, takes place, corresponding to action at the pitch point P, and on each side of this plane the rolling and sliding velocities and the radii of curvature are the same as those that occur on the actual gear teeth at the corresponding points of contact. The surfaces of the cones corresponding to wheel and pinion addendum and dedendum will obviously be as indicated in view 3 of Fig. 2, and contact could, if necessary, be extended to the interference points by extending the cones to their vertices at points I_3.

It now only remains to apply the load, and this can be done by giving an axial thrust to one of the cones to give a rate of loading corresponding to the required tooth load. If L is the thrust applied to the cones it can be shown that $L = Wp_a \sec \psi_t \tan \sigma_o$, where W is the tangential load per unit face of the gears, p_a is the axial pitch, ψ_t is the trans-

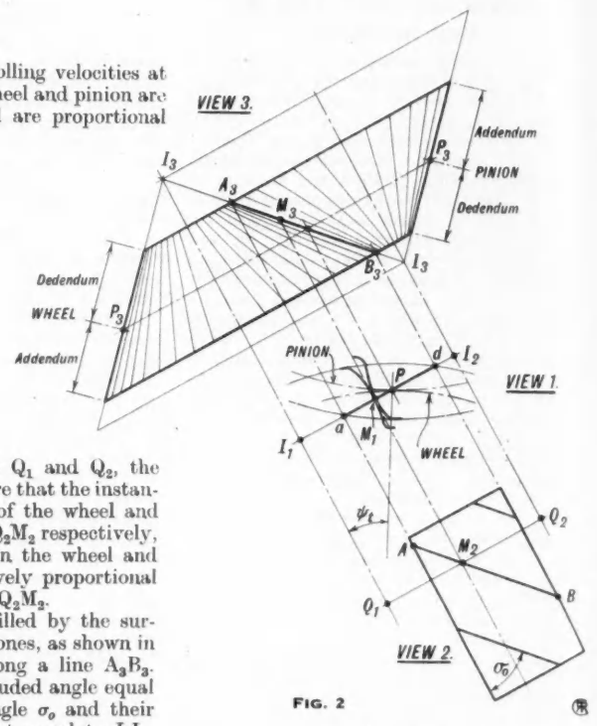


FIG. 2

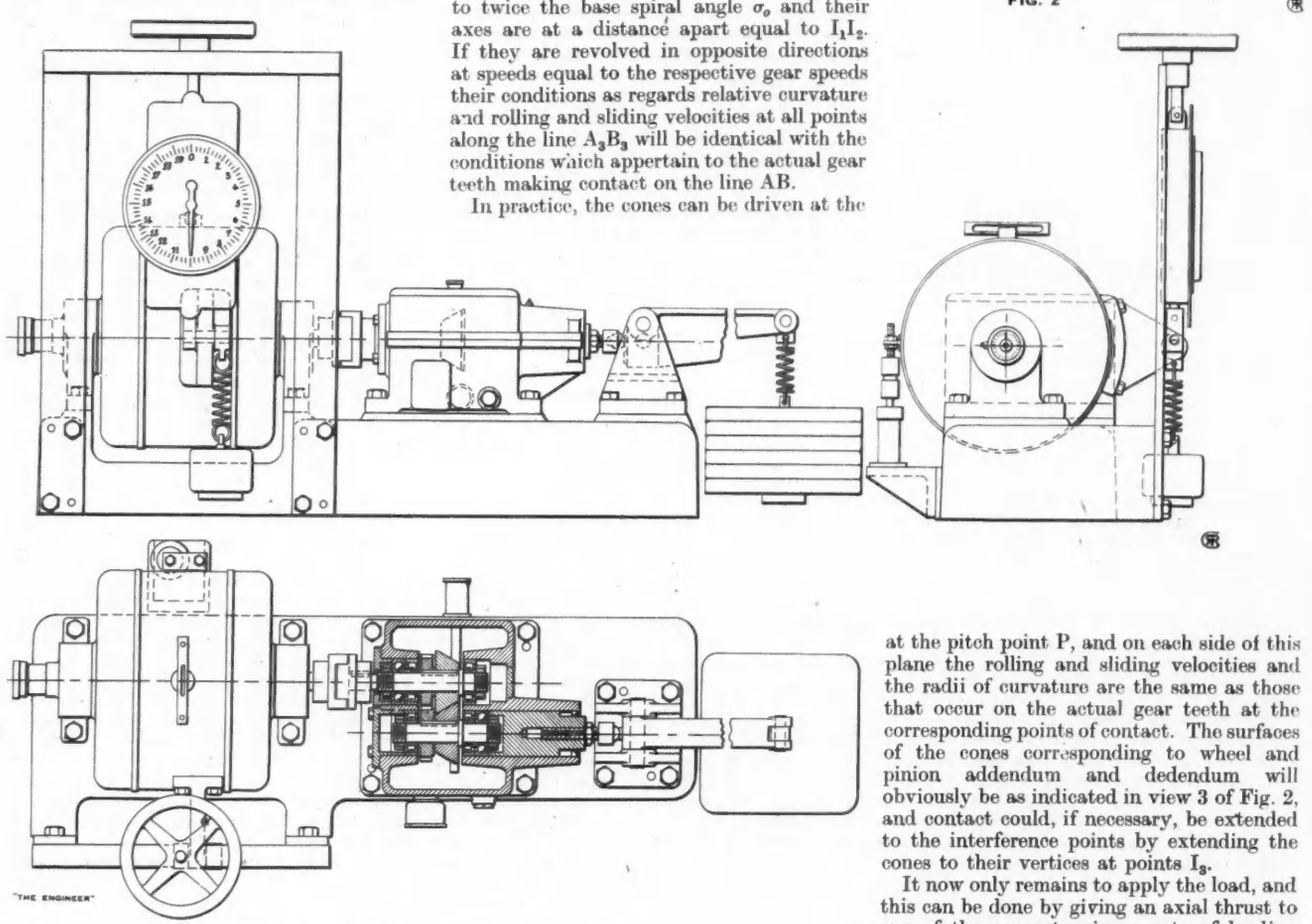


FIG. 1—HELICAL GEAR TESTING MACHINE

* THE ENGINEER, July 12, 19 and 26, 1946.

verse pressure angle and σ_o the base spiral angle.

Construction of Testing Machine

The construction of the actual testing machine is shown in Fig. 1. The cones are mounted on roller bearings in a box split on the plane containing the axes of the cones, to facilitate changing of the test pieces. The

FIG. 3

two shafts are connected by spur gears and driven from a swing-mounted variable-speed motor, capable of measuring the driving torque. The load is applied in the form of a thrust to one of the cones by means of a lever and weights. Lubrication of the cones is normally by oil bath and provision is made for keeping the temperature constant within fairly narrow limits.

Although the cones are shown keyed on to their shafts, it has been found desirable in practice to make them solid with the shafts, as although this is, on the whole, a rather more expensive arrangement, it ensures greater accuracy and more even load distribution on the line of contact.

It will readily be seen that a testing machine of this nature opens up a wide field for investigation of the various factors affecting the performance of helical gears, which would hardly be practicable if one had to make actual gears for each test and carry out prolonged experiments, either on the closed circuit principle or on the input and output method. Apart from the simplicity and inexpensiveness of the test pieces, they have the additional advantages of a more accurate control of surface finish obtainable

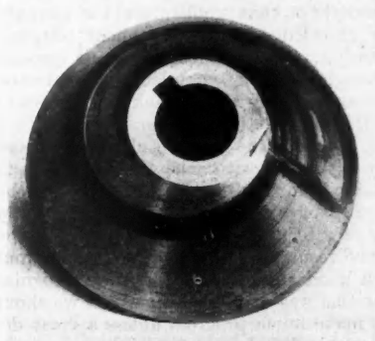


FIG. 4

on conical surfaces as compared with involute gear sufaces, elimination of experimental errors due to inaccuracies in gear tooth profile, pitch and mounting errors, and consequent unknown dynamic loads, &c. The mean diameter of the conical test piece is only about one-third the diameter of the gear to which it corresponds (the diameters are proportional to the sine of the pressure angle), thus enabling large-scale tests to be carried out in a small space. The power to drive the loaded discs is small, corresponding to the gear tooth efficiency loss only.

In the past various researches in connection with surface failure under rolling and sliding conditions have been carried out, employing machines using cylindrical test pieces. Two types of machines have been used. The first machine employs cylinders turning with uniform angular velocity, and the second type has a varying angular velocity cycle during each revolution, so that different points on the circumference are subjected to different conditions of sliding and rolling. Whilst useful information has been obtained from both these machines, they are subject to limitations in the interpretation of results obtained from them, so far as gears are concerned. The uniform velocity machine gives test results each of which can be referred to one point only on the line of action of a pair of gears. The variable velocity machine, whilst giving visual results which can be related to the varying rolling and sliding conditions along the line of action, does not take into account the varying relative curvature of the tooth surfaces at different points along the line of action.

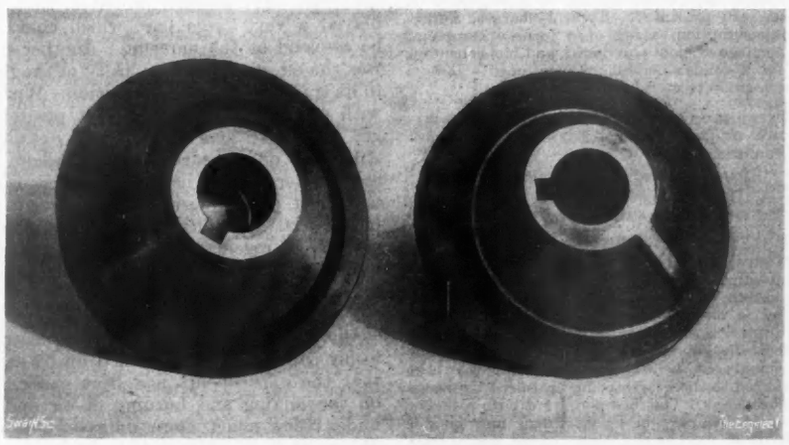


FIG. 5

Thus neither of these machines gives a picture of complete gear tooth action on one set of test pieces, and neither machine simulates the complete and true action of a pair of gears, as does the cone machine.

This fundamental advantage of the cone machine, in that it simulates completely the action of helical gears, including the effects of addendum proportions, pressure angle, helix angle and choice of pitch, enables such design factors to be investigated by direct test and observation.

A further advantage of the cone machine is in connection with the measurement of gear efficiency. In the cone machine a measurement of the torque to drive the loaded cones gives a direct measure of the power loss in the gears that they simulate, and it gives this at least as accurately as if a direct measurement of power loss were made on an actual pair of gears. The cylindrical disc machine, with non-uniform velocity, cannot be used for testing efficiency; the uniform velocity machine can be used for measurement of the coefficient of friction at individual points on the line of action, after which the calculation depends on the summation of all the varying losses at all points of contact—a somewhat hazardous calculation which calls for assumptions as to load distribution, and which is, in fact, usually based on an average coefficient of friction and the assumption of an integral tooth contact ratio.

The percentage efficiency loss in a pair of gears corresponding to a pair of cones, the smaller of which has a diameter in the rolling plane equal to d and which is found to require a torque T to drive it when loaded with a thrust L, can be shown to be equal to $2T \tan \psi_t \tan \sigma_o \times 100/Ld$, where ψ_t is the transverse pressure angle and σ_o the base spiral angle of the gears. The load per unit face of the simulated helical gears may be found from $W = L/p_a \sec \psi_t \tan \sigma_o$.

Subjects which suggest themselves as being ideally suitable for research on this machine are:—

(1) The effect of tooth design factors (pressure angle, helix angle, choice of pitch and addendum proportions) on durability and efficiency.

(2) The relative merits of different combinations of materials in regard to durability and efficiency.

(3) The effect of different surface finishes on durability and efficiency.

(4) The relative values of different lubricants in respect of durability and efficiency.

(5) Fundamental problems of pitting, scuffing and other forms of surface failure as influenced by speed, pressure and relative rolling and sliding velocities.

Results of Tests

The photographs reproduced in Figs. 3, 4, and 5 show the results of a few preliminary running tests which have been carried out on various cones. The one in Fig. 3 is an "all-dedendum" cone in which the rolling plane is on the largest diameter. Pitting has started near the rolling plane and is extending along the cone towards its smaller diameter. This means that on the actual helical gear to which the cone corresponds, pitting would start near the pitch line and extend along the line of contact towards the bases of the teeth.

Fig. 4 shows a cone on the surface of which is a raised spiral band, $\frac{1}{4}$in wide, the rest of the surface having been relieved by milling. The purpose of this is to ensure an even load distribution. This cone has its rolling plane approximately on its mid-diameter, and it is made from phosphor bronze. Pitting has occurred at a point corresponding to the dedendum flank at a specific sliding value of -55 per cent.

Fig. 5 shows a pair of cones in heat-treated steel, again with the spiral band, which have

been subjected to a scuffing test. On these cones the rolling plane is about midway along each cone. These were subjected to increasing load until scuffing occurred. In both cases scuffing commenced at the outer end of each cone, corresponding to maximum sliding velocity. Each further increment in either load or speed caused an extension of scuffing along the surface of the cone. It will be seen that the dividing line between the scuffed surface and the good surface is clearly defined and lies in a plane normal to the axis of the cone indicating that there is probably a well-defined relation between the load and the speed required to cause scuffing. The machine would appear to lend itself particularly to an investigation of this relationship, which has a direct bearing on the problem of high-speed heavily loaded reduction gears which aircraft manufacturers are at the present time endeavouring to adapt to gas turbine propulsion.

The Iron and Steel Institute

No. III—*(Continued from page 476, May 30th)*

A JOINT discussion then took place on the following papers :—

THE OPERATION OF OPEN-HEARTH FURNACES WITH COKE-OVEN GAS

By D. KILBY.

SYNOPSIS

The paper deals with the operation of 100-ton basic open-hearth furnaces at the Redbourn Works of Richard Thomas and Baldwins, Ltd., Scunthorpe, which are fired with coke-oven gas and pitch-creosote. Details of design and construction of furnaces, layout of the pitch-creosote main, design of gas burner and atomisers, operation of furnace, and chief factors affecting smooth working are presented. Typical charges, refractory consumption, a log of a furnace campaign with tonnage of ingots produced, and fuel consumption for a similar period are mentioned. Details of pitch-creosote are also given.

AN EXPERIMENTAL FURNACE FOR THE INVESTIGATION OF OPEN-HEARTH FURNACE COMBUSTION PROBLEMS

Part I.—DESCRIPTION OF PLANT.

By A. H. LECKIE, Ph.D., J. R. HALL, and C. CARTLIDGE.

SYNOPSIS

An experimental furnace specially designed for the investigation of some of the variables affecting open-hearth furnace fuel efficiency and rate of melting is described. The serious experimental difficulties associated with operation at melting temperatures have been avoided by conducting the experiments at a lower temperature, the heat transferred to the hearth being measured by means of calorimeters. This has permitted both a higher degree of accuracy in measurement and greater freedom of experiment than would have been possible, if the small-scale melting of steel had been undertaken. The experiments have been designed and regard paid to appropriate similarity criteria so that the results obtained at lower temperatures can be applied to melting practice.

DISCUSSION

Mr. W. Geary (Appleby-Frodingham Company, Ltd.) thought the authors of the second paper had been right in deciding to do low temperature work and not carry out their experiments at steel-making temperatures. It would have been impossible otherwise to get such clear evidence of the fundamental problems. It was no exaggeration to say that the last two years had seen more advance in our knowledge of the fundamentals than probably had been the case during the previous twenty years, and it could now be said that sufficient was known of these fundamentals to justify building a small experimental furnace that would work at practical steel-making temperatures and actually make steel. Referring to the paper by Mr. Kilby, he said there was a good deal of research work going on in regard to burner design and at the moment he did not think there was a composite burner available that could be called efficient when burning 100 per cent gas or 100 per cent liquid fuel. There were cases where it was cheaper to avoid an illuminant and use coke oven gas, which involved a higher fuel consumption, but that statement was a little misleading because it was not a reasonable commercial proposition without an illuminant, unless very high proportions of scrap were used in the charge.

Mr. R. W. Evans (Guest, Keen and Baldwins Iron and Steel Company) said that an important point to bear in mind when working with an inside surface temperature of about 1600 deg. Cent. or higher, was the effect of the properties of reflection of the surfaces back on to the bars in the actual transfer of heat from the flame to the bar. It seemed probable that this played a very large part which could not be assessed at the moment. Another point was the effect of the luminosity of the flame in its transfer of heat by radiation. Working with gas generators, it was not possible to get the conditions which were obtainable with the open hearth furnace where gas regenerators were being used because of the effect of luminosity. Therefore, it was hoped that the authors would be able to work with regenerators and thus get more information on the part which luminosity must play in the transfer of heat.

Dr. Leckie, briefly replying to the discussion, said he thought the work described in his paper could be summed up by saying that the experiments had been carried out on the mixing and burning of air and gas under very much more unfavourable conditions than in practice. At high temperatures the gases would burn more quickly owing to the fact that the chemical reactions were faster and would radiate heat more readily at high temperatures owing to the ordinary laws of radiation. Therefore, if the conditions applying to heat transfer at low temperature could be analysed it could safely be said that these results would apply to high temperatures and the heat transfer would be even better.

The last papers to be presented on Thursday, May 15th, were :—

APPLICATION OF SLAG CONTROL AND AN INVESTIGATION OF BASIC OPEN-HEARTH FURNACE SLAGS

By T. FAIRLEY, Ph.D., M.Sc., F.Inst.P., A.F.R.Ae.S., F.I.M.

SYNOPSIS

A method of slag control for fixed basic open-hearth furnaces which is based on a combination of existing practices is described, and the results are given of a statistical survey of the chemical compositions of the melting and tapping slags of 250 casts made by the application of this method. Graphs correlating the values of slag basicities as determined by different formulæ are included.

THE EFFECT OF TEMPERATURE ON THE PHOSPHORUS REACTION IN THE BASIC STEEL-MAKING PROCESS

By K. BALAJIVA, B.Met., Ph.D., and P. VAJRAGUPTA, Ph. D., A.R.S.M.

SYNOPSIS

Following the previous laboratory investigation of the phosphorus reaction in the basic steel-making process at 1585 deg. Cent., the work has been extended to two other temperatures, that is, 1550 deg. and 1635 deg. Cent., employing in each case a series of slags of varying lime content and with compositions covering the normal range of basic practice, the experimental technique being similar in all respects to that already described. It is shown that, at steel-making temperatures, the empirical relationship between the total lime content of the slag and the phosphorus equilibrium constant $\left(k=(P_2O_5)/\{[P]^2\times(FeO)^5\}\right)$ can be defined by the general linear equation : Log $k=n$ log $\Sigma CaO-c$, where the gradient n remains constant whilst c varies with temperature. Application of this relationship in controlling dephosphorisation in industry is indicated.

In addition, an X-ray examination of the rapidly quenched slags obtained in the present work has been carried out, and the results confirm the findings regarding the constitution of basic slags previously reported for the work at 1585 deg. Cent.

DISCUSSION

Mr. N. H. Bacon (Steel, Peech and Tozer, Ltd.) said that Dr. Fairley had mentioned at some length in his paper the ways and means that could be adopted to decide what the basicity of the slag should be, but all three available formulæ were very unsatisfactory as a measure of basicity. What was very badly wanted was some means of deciding from the data obtained from a furnace, as the result of chemical analysis, a formula which would bear some true relationship to the basicity of the slag. Something should be done to encourage co-operative research on slag/metal reactions and slag control, and it was to be hoped that Dr. Leckie's wish would come true and that an experimental furnace for making steel would become available.

Dr. A. G. Quarrell (British Non-Ferrous Metals Research Association) said that Dr. Fairley had carried out a statistical investigation on a number of melts and by rationalising the procedure adopted had been able to effect a considerable improvement in the steel-making technique employed in his works. At the same time, although this treatment had led to considerable improvement in technique, Dr. Fairley would be one of the first to admit that it would be unlikely to increase our understanding of the physical chemistry involved in steel making. This method could not be responsible for any considerable improvement in steel-making practice. The second authors, on the other hand, had used a laboratory method to investigate in such details as was at present possible, the reactions occurring between slag and metal, and it must be admitted that they had thrown some light on that problem, and had increased our knowledge of the chemical principles underlying the dephosphorisation process, although not a completely satisfactory treatment owing to the lack of information on the constitution of liquid slags. There was, however, the need for checking up such investigations with the practical results obtained in the steel-melting shop, but there was great scarcity of data for checking any new formula which might be developed as the result of laboratory work. It would be a good thing if the Institute recognised that this was a problem in which we should not make much progress unless a great deal of reliable data from practice was on record. There were records available in the hands of various people but they were not readily available, and therefore laboratory workers hesitated to put forward their results because they could not confirm them by practical experience.

Dr. L. Reeve (Appleby-Frodingham Company, Ltd.) said there was one method of slag control which he was surprised was not mentioned in Dr. Fairley's paper, because it was a promising one. He referred to the

pH method which had been mentioned in American papers, *i.e.*, the determination of the direct basicity of the slag suspended in water. A little work had been done on that at the Appleby-Frodingham works at Scunthorpe and the results so far seemed to show there was a good deal in the method. It took only a few minutes and showed promise of being something considerably better than the slag pancake method, which he had found absolutely useless, or the colour methods, which were very difficult to follow. He thought it was true to say that the fundamentals of the factors controlling the basicity of a slag were not known although a little light had been thrown on them by the very excellent work of their late lamented Dr. Jay, who did some wonderful work in this field, from which it appeared there was a direct relationship between the *pH* value and the X-ray method.

Dr. J. White (Sheffield University) said some years ago he did some work which was undertaken in an attempt to work out a constitution which would explain the metal/slag relationship. From that work he had come to the conclusion that the law of mass action should, in time, be able to explain the constitution of slag. We had got along very well with the other reactions without bothering too much about the slag but when it came to the phosphorous we were hopelessly up a tree unless we had some knowledge of the slag constitution. It was necessary to know the concentration of the free lime before it was possible to get an actual value of the constant. It was possible to give empirical values to the constants but it was not possible to put the thing on a fundamental basis without a knowledge of the values of the "free" oxides, because we did not know exactly what that meant.

The authors replied briefly.

The final session was held on Friday morning, May 16th, when there was a joint discussion on the "First Report of the Rolling-Mill Research Sub-committee of the Iron and Steel Industrial Research Council," and the following papers:—

Fluctuations of the Distribution of Torque Between Rolling-Mill Spindles.

By E. A. W. Hoff.

Synopsis

The paper describes fluctuations of torque found when the torques acting in the two connecting spindles of a two-high rolling mill were recorded separately and independently during the operation of the mill. Some of these fluctuations were periodical and in step with the roll revolutions. These are attributed to mechanical imperfections of the driving gear. Other non-periodic fluctuations are thought to be caused by the surface condition of the rolled stock. In an Appendix it is shown that none of the fluctuations found could have originated from the universal joints of the spindles.

The Application to Shaping Processes of Hencky's Laws of Equilibrium.

By E. Siebel.

Synopsis

The increase in pressure along slip lines, and the relationship between the mean pressure and the principal stresses as well as between the slip lines and the stress trajectories are discussed. Rules regarding the formation of slip lines are outlined. Slip-line systems and stress conditions on compression, and the resistance to flow between rough plates with constant and with varying friction at the compressing surfaces are analysed, allowing for the form of the free surface on compression. The gradual advance of slip layers in direct compression processes is explained and diagrammatically illustrated. Slip lines and stress conditions in cupping and related processes are described and consideration is given to die friction and the cohesion of the metal. Slip lines and stress conditions in pressing processes are elucidated, followed by a discussion on the various systems of slip layers. The effect of work-hardening is explained mathematically.

Discussion

The President, commenting on the historical side of this work, said that in the introduction to the Report it was mentioned that when the committee decided to undertake experimental work it made use of the mill that had been set up in Sheffield University. As far back as 1929 it was decided by the manufacturers of cold rolled strip to present the university with an experimental mill, and that was set up through the generosity of the Worshipful Company of Ironmongers. It was the intention to carry out quantitative work on that mill, and the first subject to be investigated was the difference between plain and roller bearings, the mill being provided with these alternative bearings. A strain gauge was also devised by which the strain during the passage of the materials through the rolls could be measured. But these things had only just been set up when he himself left Sheffield to go to the National Physical Laboratory, and the mill remained without much use being made of it for some years. However, when the Rolling Mill Sub-committee decided to make use of the mill, they transformed it completely and the report showed what a very great deal of ingenuity had been shown in converting the original comparatively crude machine into a piece of real research apparatus. Since then, a lot of most valuable work had been done and it had all been a very good instance of collaboration between mill managers on the one hand, the research team working in the Sheffield University, and those who were attacking the problem from the very strictly physical point of view, *viz.*, Dr. Orowan and his collaborators at Cambridge. The combination of these three sets of people had led to very good results.

It was quite clear that there was very much to be done on the engineering side of the problem, and there was also very much to be done on the study of the physical processes involved in cold rolling. But even these two very important fields of research left out of question the phenomena of hot rolling, where, of course, there was a great deal of recrystallisation and other complex processes going on during deformation.

The paper by Siebel recalled the fact that some sixty or seventy years ago some very active work was being done in France, which had been overlooked. A series of papers by Tresca was quite remarkable in showing the process of deformation in a number of curves. That was taken up by Hartmann, also in France, and his book on deformation gave diagrams almost identical with those of Siebel. The methods of measurement were not perfected at that time and much evidence had to be gathered from the flaking and scale on the surface, but a study of the early papers of Tresca showed that a great deal of attention had been given to the problem of deformation of metals in rolling, and the results were really quite remarkable for the time. But we now had the advantage of being able to measure the forces involved in deformation with great accuracy on account of the great development of electrical measuring instruments. This report showed the very great advantage of complete collaboration between the actual mill managers and research investigators. The relations had been very friendly and the investigators had been given every facility by the firms possessing rolling mills. At the same time, there was much work still to be done both in the laboratory and in the field, and certain firms had now every facility for attaching instruments to their mills to find out the forces operating during the ordinary running of the mills.

Dr. J. W. Maccoll then presented a collective contribution from the Armaments Research Department at Port Halstead. He said his own interest lay in the mathematical application of the theory of deformation and he had a small group under his charge dealing with that aspect. During the early stages of the war they came across very many problems which required some knowledge of plastic deformation work, and in 1941 a start was made to collect a small group of workers together to work on these problems. From that work it soon became evident that the developments that had taken place up to 1930 were not as adequate as might be desired. Although, from a superficial point of view, many problems appeared to be solved, they were solved rather qualitatively than quantitatively. Therefore, the team of investigators that had been working at Halstead during the last few years had produced a number of papers which were in process of being issued. These dealt with the general scientific principles and it was hoped that this work would be of interest in several fields, including the field covered by the Institute. He felt that the position now from the scientific point of view was that we were getting to the stage when it could be said that almost any two-dimensional problem in plastic deformation could be solved to adequate accuracy provided the necessary physical data could be fitted into the problem. Little had been done, however, in regard to three-dimensional problems, and that would be one of the major fields of further work.

Mr. R. Hill (Armament Research Dept.) discussed Siebel's results and challenged their accuracy in every case. He said that one point vital to the correct solution of any plastic problem was that the stresses could only be calculated by simultaneously considering the velocities of flow and the strains. That was obvious enough when considering a problem about the boundaries of the material as in hardness testing, where the metal surface was displaced continuously during the indenting, but the point was less obvious and appeared to be overlooked when one was dealing with a steady motion problem like extrusion or drawing or rolling, and that problem was being statistically examined. Siebel was aware of this but what he was not aware of was the way to find the one slip line system which actually solved the problem. He showed on the blackboard what he regarded as the correct slip line system and expressed doubt as to the accuracy of most of Siebel's results and conclusions.

Dr. E. Orowan, F.R.S. (Cavendish Laboratory, Cambridge) emphasised that there had been a very significant development since the beginning of the last war and that our outlook on these problems between the wars had now completely changed. He divided the interval between the wars into three periods, *viz.*, from 1920 to 1925, from 1925 to 1945 or 1946, and the present time. In the first period there was really no theory at all. During the second period a theory was developed in which it was considered that the main effect which caused the pressure to be above the yield stress of the material was the accumulation of stresses due to the friction at the rolls,

and now we were entering the third period, in which the theoretical outlook had been changed and there were now said to be three causes why the main pressure must be higher than the yield stress. It was clear that elastic deformation could not be neglected and that it played an important *rôle*. There was a minimum thickness of strip that could be rolled and there was a fairly well defined limit below which it was not possible to go with a given roll diameter.

Mr. G. M. Brown (Chesterfield), commenting on Dr. Orowan's remark that there is a minimum thickness of strip that can be rolled, said he regarded that as purely an elastic problem, and he had recently got out a formula for it. Continuing, he said we do not know much about friction in rolling at present, but had to assume there was a certain frictional effect. It was an important question in relation to rolling and it was astonishing that so little was known about it. At present a constant coefficient of friction was assumed but most methods of calculation fell down on this point. Much information about the coefficient of friction could be obtained by a careful and painstaking analysis of the curves of Siebel and Lueg; he regarded these as a great mine of information if they were carefully examined. On the whole, he felt that the question of friction had been overlooked.

The president remarked that the Rolling Mill Research Sub-committee had this question of friction under consideration, and he did not think anyone had assumed frictionless conditions.

Dr. Ford said it was quite clear that from the work now being done on cold rolling that there would be further headaches for the engineer, both as regards design and operation. At Sheffield an enormous number of experiments had been made over quite a wide range of cold rolling conditions and they had been able to use the theory which Dr. Orowan had described before the Institution of Mechanical Engineers. They had been endeavouring to ascertain how best to use that method, with practical calculation methods, in order to devise a quick and fairly easy means which would give reasonable accuracy over a definite range of phenomena. A series of papers on that work was in course of preparation, and he believed they had been able to arrive at a synthesised method based on a sound theoretical analysis which would enable reasonably good results to be obtained from quite simple physical measurements and simple calculations.

The authors of the papers were cordially thanked and the meeting closed.

Progress in Petroleum Research*

By ROBERT PRICE RUSSELL†

No. I

Expansion of World Demand for Liquid Fuels

AS we look at the petroleum industry through the eyes of the research scientist, we see certain positive trends which will undoubtedly determine the nature of our activities, at least during the next decade. The increase in the world demand for liquid fuels is, without a doubt, foremost among these trends.

Fig. 1 shows the distribution of world energy sources through 1938, the last year of normal consumption. The percentage of the total world energy supplied by petroleum and natural gas increased from about 16 per cent in 1925 to about 23 per cent in 1938. To-day we believe it to be close on 30 per cent, and evidences of this vast increase are apparent throughout industry and commerce. In 1914 only 4 per cent of the world's merchant fleet tonnage ran on oil, but by 1945 over 75 per cent was oil burning. The diesel horsepower installed in the United States increased from 5½ million in 1935 to 45 million at the end of 1945. The recent war provided a striking example of the growth in our dependence on oil for energy. A typical division in 1918 had 4000 h.p. behind it, but in 1945 its mechanised counterpart required more than 187,000.

A decline in coal production in almost every country of the world has coincided with the rise in total energy requirements. Atomic power as a prospective source of energy will probably have little effect on the demand for liquid fuel. My own view is that while atomic energy will probably find important peacetime applications, it will compete for decades to come mainly in the field of large power or heating units now fuelled with coal.

Another major trend bound to influence oil research and development is the increase in octane number of petrol and the corresponding rise in engine compression ratio. Fig. 2 shows the extent to which the octane number of petrol has increased in the United States during recent years. By and large, it parallels the increase in compression ratio, which is a measure of the engine's ability to utilise the power of the fuel. During the war the highest octane petrol constituents were reserved for military uses, with a consequent decline in wartime petrol quality, but immediately afterwards an improvement occurred in the quality of motor petrol and the best premium grades progressed to a point well above pre-war rating. Again in 1946 there was a slight decline in quality due to a temporary shortage of tetra-ethyl lead, but we know now that the stage is set for a further rise in both octane number and engine compression ratio.

Over the years it has proved necessary for the industry to alter the proportions of the various products made from crude petroleum, and the dominating factor here has been the sharp upward trend in petrol requirements. The demand for petrol has been met through reducing the proportionate production of other oil products. For example, in 1920 the petrol produced in the United States amounted to only 26 per cent of the crude runs. By 1940, however, the petrol yield had been stepped up to 43 per cent, while the development of oil cracking has made it possible for us to adjust within a wide range the proportion of petrol and other petroleum products obtainable from a barrel of crude oil.

Still another trend that will have a pronounced effect on oil research is the increasing cost of finding and producing petroleum. This has already imposed on the industry the need for more efficient refining methods and has stimulated investigation into other available sources of liquid fuel. A considerable part of the present research and development effort of my own company—nearly one-third of that effort, in fact—is directed to the conversion of natural gas and coal to liquid fuel. The emphasis placed on this field of research and development is not due basically to any fears of future oil shortage. Competent oil geologists have estimated that our proved reserves of crude oil will be greater twenty years hence than they are to-day, and that we shall have plenty of oil for the next 100 years. But the time is already at hand in some parts of the world when liquid fuels from gas and coal are becoming competitive with petroleum products.

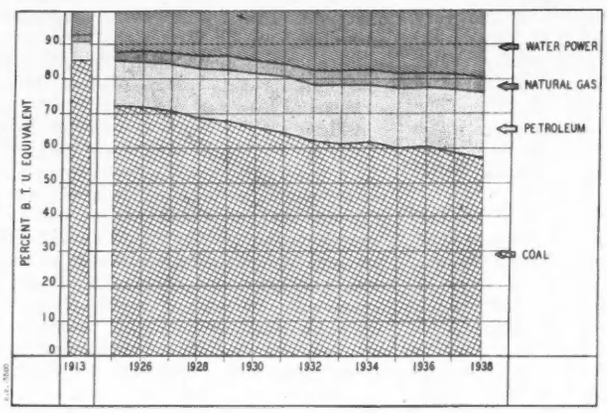


FIG. 1—PRINCIPAL SOURCES OF WORLD ENERGY

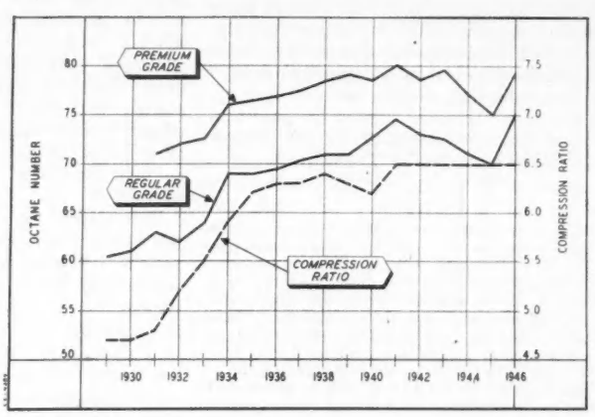


FIG. 2—PETROL QUALITY IN RELATION TO COMPRESSION RATIOS

* Second Cadman Memorial Lecture. The Royal Institution, June 4, 1947. Abstract.

† President, Standard Oil Development Company.

Chemical developments in the petroleum industry are important to our economy, but the volume of chemicals produced is small in relation to the industry's output as a whole. One half of 1 per cent of the world's annual crude oil production would supply the world's entire rubber needs, while nine-tenths of 1 per cent would take care of the world's alcohol requirements for industrial purposes, and even for beverages. The wide range of chemical and synthetic products now being made from oil utilises only a fraction of 1 per cent of the total world production. As we look at the industry to-day, we see that the principal function of petroleum is that of liquid fuel, and I think it may be assumed that for many years to come petroleum will serve chiefly as a source of energy.

Improvements in Techniques of Oil Refining

The developments I propose to discuss are the results of research in petroleum refining and their chief applications is in the production of more abundant and more efficient liquid fuels, although this is by no means the limit of their usefulness. For, as is so often the case in research, each new area of discovery has opened up other interesting and useful fields.

The first of these processes is fluid catalytic cracking, the result of a development brought to the stage of commercial availability not long before Pearl Harbour. The second is hydro-carbon synthesis, an allied process which has opened up real possibilities for utilising coal and natural gas in the production of liquid fuels and also of a wide variety of chemical products.

Catalytic cracking was first developed as a means of improving motor petrols. To meet the two-fold demand for increased petrol yield and also for sharply improved anti-knock characteristics, the oil industry turned to the use of catalysts. It was found that by carrying out oil cracking in the presence of catalysts consisting of clay and related solid synthetic materials, the cracking process could be operated at lower pressures and temperatures and with shorter times of reaction than those employed in earlier thermal cracking units. Moreover, the catalytic reactions gave better overall yields in addition to greatly improved product quality.

When catalytic operations were first applied on a large scale in the oil industry, the catalyst was used in stationary beds as lumps or pellets over which the materials to be processed were passed as vapours. This was true of both the high-pressure hydrogenation and hydrocatalytic cracking processes developed by my own company on the technical foundation laid down by the I.G. Farbenindustrie in Germany and of the later catalytic cracking process pioneered by Eugene Houdry.

There is no particular difficulty in carrying out fixed bed catalytic cracking batchwise on a small scale, but large-scale production gives rise to many practical difficulties. The development of a continuous process seemed desirable in order to avoid complicated valving, heat removal problems, and difficulties in temperature control. These problems finally reached solution in a totally new type of catalytic cracking, placed in large-scale commercial operation about five years ago and known as the fluid catalytic cracking process.

Because of its inherent simplicity and certain unique advantages, the fluid process has a wide variety of potential applications in the oil industry and other fields. Before reviewing some of these applications, it might be as well to explain the basic features of the fluid process.

The term "fluid" is applied to this type of catalytic cracking because the finely divided catalyst actually behaves like a fluid when aerated by a gas or vapour. Samples of this catalyst, when placed in a bottle, behave just like flour or clay. It is sluggish in movement and travels with difficulty as the bottle is tilted. But when the bottle is shaken vigorously the whole mass becomes fluid and seeks to find its own level with each movement of the bottle, in a manner similar to water.

In the operation of the fluid catalytic cracking process (Fig. 3), preheated oil vapour produced by flash vaporisation enters a reactor, carrying along with it the catalytic material as a suspended powder. Because of the decreased velocity of vapours passing through the reactor, the suspended powder settles out to form a relatively dense, bubbling bed. Cracking proceeds in this bed at a temperature of about 900 deg. Fah. as the rising oil vapours contact the active solid, and is completed in about 20 sec. Product vapours then leave the bed, pass through a settling zone to a cyclone separator, carrying with them catalyst still in the form of a suspended powder. Here, a large part of this suspended powder is recovered and returned through a small standpipe to the catalyst bed.

The vapours—substantially catalyst free—proceed to a fractionator where they are separated into gas, high octane petrol, heating oil and gas oil fractions. A very small percentage of the catalyst escapes from the cyclone, but is recovered as a heavy oil slurry at the bottom of the fractionator, from which it is pumped back into the reactor.

Meanwhile, the catalyst, separated from the cracked oil vapours, is withdrawn from the bottom of the reactor and discharged into an air stream which carries it in suspended form to the regenerator vessel. Because of the decreased velocity of the carrying gas, another violently bubbling bed is formed in this vessel, and the carbon deposited on the catalyst during its passage through the reactor is burned off in the regenerator bed at a temperature of 1100 deg. Fah. The purified catalyst is separated from the spent air, first in a settling zone above the bed and then in a cyclone separator, after which it is returned through a standpipe and control valve into the stream of hot oil vapour. At this point it begins a new journey into the reactor, and a fresh cycle of operations.

The spent air leaving the cyclone passes through an electro-static precipitator where the final traces of catalyst dust are recovered and returned in suspended form to the regenerator bed.

Remarkable results are produced by the violent action in the fluid catalyst beds. For example, in a plant scale regenerator as much as 200 million B.Th.U. per hour may be liberated, yet the temperature in the regenerator seldom varies more than 5 deg. Fah. from top to bottom. This minor temperature variation, compared with the enormous heat liberation, is realised even though the seething catalyst bed may be 20ft deep and up to 45ft in diameter.

Of particular interest is the fact that the complete cycle takes place without the use of a single mechanical moving part. It is the fluid condition of the catalyst which makes this possible. A pressure head is developed by the catalyst in the regenerator standpipe. This pressure is sufficient to cause the catalyst to flow from the regenerator (a zone of relatively low pressure) through the regenerator slide valve into the reactor (a zone of relatively higher pressure).

The average particle of catalyst makes its

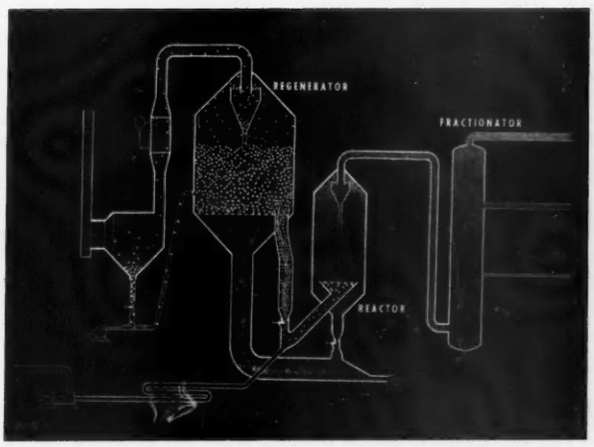


Fig. 3—Fluid Catalytic Cracking Process

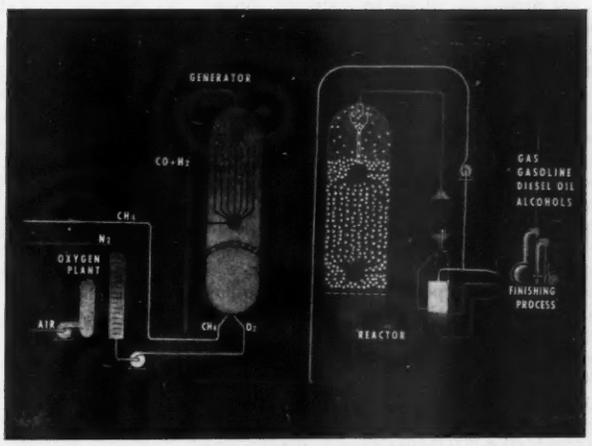


Fig. 4—Hydrocarbon Synthesis Process

way around the complete circuit every ten minutes, yet the process runs continuously for months on end.

A large-scale fluid catalytic cracking unit is capable of handling 1¼ million tons of feed stock per year, or some 25,000 barrels per day. Such units are about 250ft high—as lofty as a twenty-storey building—and contain more than 24 miles of piping, of which one section may reach 8ft in diameter. Some 40 tons of catalyst (as much as can be loaded into four railway wagons) are circulated through the unit every minute, yet the catalyst recovery is so complete that only 0·005 per cent of the 60,000 tons circulated daily is lost to the air.

By virtue of its flexibility the fluid catalyst cracking process can be used to control almost at will the product distribution and quality obtained from a given refinery. For example, gas oil fractions can be cracked in once-through operations with direct petrol yields of from 45 to 55 volume per cent. These petrol yields are raised to 55 or even 65 per cent by simple polymerisation of low molecular weight unsaturates. Yields such as these may be obtained in once-through operation without the production of any heavy fuel oil whatsoever from the virgin gas oil processed, while by recycling operations it is possible to increase further the yields of petrol from gas oil. It has even been found possible to crack heavy residue catalytically without the production of tar and obtain high yields of motor petrol directly comparable in quality with that obtained when processing light gas oil fractions. A comparison of results from thermal and fluid catalytic cracking is made in Table I. The uniformly high octane level of the catalytic petrol, relative to the thermal product, is particularly worth noting, together with the high yield of petrol, both in single-pass and recycle operations, and the absence of tar production in most of the catalytic operations.

The fluid catalyst technique was brought to full development just in time, for although it had received large-scale pilot plant demonstration, no commercial plants were yet in operation when we were suddenly confronted with the demand for enormous wartime supplies of aviation petrol and vast amounts of raw materials for synthetic rubber.

The first commercial fluid catalyst cracker went into successful operation in Baton Rouge, Louisiana, on May 25, 1942. Even

TABLE I.—*Comparison of Results from Thermal and Fluid Catalytic Cracking*

Operation, feed stock.	Heavy paraffinic gas oil.			
	Thermal cracking partial recycle.	Fluid catalytic cracking.		
		Single pass.		Recycle.
Catalyst.	None.	Silica-alumina.	Magnesia.	Silica-alumina.
Yields :				
Petrol+polymer, vol.-per cent	38·9	57·2	63·1	75·3
Excess C_4, vol.-per cent ...	Nil	3·3	Nil	6·5
Cycle oil, vol.-per cent	40·0	40·0	40·0	4·5
10 deg. A.P.I. tar, vol.-per cent	20·1	Nil	Nil	7·8
Coke, wt.-per cent	Nil	3·5	3·5	10·6
Dry gas, wt.-per cent	4·3	5·6	4·2	7·6
Octane number petrol+polymer :				
A.S.T.M. clear ...	72·6	81·1	79·8	83·1
C.F.R.R. clear ...	82·5	95·7	93·1	95·7
C.F.R.R.+1·5 cc T.E.L. ...	89·0	99·3	97·3	98·5

before this plant was completed, the process had been chosen by war-planning groups and by refining organisations of the United States for some thirty plants. These were required to produce the base stock and alkylate raw materials for nearly half of the then projected output of 100-octane aviation petrol as well as for a considerable portion of the normal butylene and *iso*butylene needed for synthetic rubber. That they did so is now a matter of history, for the Allies were never lacking in vital supplies of 100-octane aviation petrol.

At the present time, thirty-eight fluid catalytic cracking units are in existence in the refineries of nineteen oil companies, and thirteen additional units are under design or construction in the plants of nine companies. The capacity of fluid catalytic cracking plants installed, under construction or on order, has reached the amazing total of nearly 60 million tons per year, or 58·5 per cent of all the installed catalytic cracking capacity in the world outside Russia. The extremely rapid expansion during the war years is a point of interest worth noting.

Benefits to the Motoring Public

Before proceeding to a discussion of other applications of fluidised technique, it seems desirable to point out what long-range benefit to the public will result from these advances in the technique of catalytic cracking. Motor gasolines can be made to-day with existing catalytic cracking equipment and by other fully developed processes to operate in cars with engines of 9·5 to 10 compression ratio, as against the present average compression ratio of slightly over 6. From the standpoint of the motorist's pocketbook, these figures have a very real significance. A car giving performance equal to the best obtainable from present-day models, but designed to take full advantage of these new anti-knock petrols, would show a substantial gain in miles per gallon. For example, a modern American car with a compression ratio of 6·6 to 1 will cover, let us say, 17 miles per gallon at 40 miles per hour on a level road. A car fully designed for a 9·5 compression ratio engine would achieve 24 miles per gallon. This represents an improvement in mileage of 40 per cent—no small figure.

Assuming that the motorist normally pays 2s. per gallon for petrol for his 1947 model, with his new model fully designed to take advantage of high octane, he could afford to pay 2s. 9d. per gallon. Now in the normal course of events he will not have to pay any such amount, because the added cost of making the new product, we know, will be far less than its increased value to the motorist.

The motoring public may therefore look forward not only to a saving in its annual petrol bill, but also—according to experts in the automotive industry—to the building of cars with high-compression ratio engines at no greater cost than that of present-day cars. Further, from the standpoint of the people and the world as a whole, there is the advantage that would result from a still greater conservation of our petroleum resources.

Catalytic cracking may also contribute towards meeting world requirements of gas turbine fuels, since the process, while converting a large fraction of the raw materials fed to it into high octane petrol, simultaneously lifts into the boiling range of kerosines and light gas oils a considerable additional segment of the higher boiling fractions fed to it. These products, either as such, or possibly after saturation type hydrogenation, may conceivably find application as jet and gas turbine fuels.

(To be continued)

The Royal Society's Conversazione

At the Royal Society's conversazione, held at Burlington House, London, on the evening of Thursday, May 29th, an exhibit of outstanding interest—certainly from the more popular point of view—was a mechanical model illustrating the uranium chain reaction shown by the Science Museum. The model consisted of thirty units, each representing the nucleus of a uranium atom. Each unit was something like a mouse trap, indeed, we understand that in the first version of the model actual mouse traps were used. As finally developed, each unit consisted of two flat surfaces or flaps hinged together but provided with a spring and catch whereby they could be "set" to "go off" under light pressure on one of the flaps—the one on which the mouse steps. The other flap instead of carrying a piece of cheese had three round holes cut in it in each of which a ping-pong ball rested. These balls represented the neutrons of the uranium nucleus.

The thirty units were disposed on the floor of a large case with glass sides and a glass top. In the roof of the case was a receptacle from which a single ping-pong ball could be allowed to fall on to the trigger flap of one of the units. On the release of this unit its three balls were shot upwards, striking the roof and rebounding from the sides in a haphazard manner. The chances are in favour of at least two of the three balls striking the trigger flaps of other units, the balls of which are released in a similar manner, to carry on the reaction in a multiplying ratio. In from five to fifteen seconds after the release of the initial ball the case appears full of balls in motion. Thereafter the action dies down. In the demonstration which we witnessed we observed that out of the thirty units five had failed to be released. The percentage of "failures" varies from trial to trial. On some occasions there may be an almost complete "misfire," but usually nearly all the units "go off."

One or two interesting possibilities exist of modifying the model to demonstrate additional features of a chain reaction. For example, if the floor of the case and perhaps some of the glass sides are covered with velvet, the activity of the balls is damped down and fewer releases are obtained. This effect corresponds with controlled fission, the aspect of the subject in which engineers may one day find chief interest. It will be their task so to regulate the insertion and withdrawal of the "velvet" that the reaction proceeds without running away into an explosion or dying out altogether. Again, if a hole is left in the sides or roof of the glass case, some of the balls will escape and take no further part in the action. If the holes were sufficient in size or if the glass case were entirely removed the chances are that no chain reaction would take place or that any such reaction as did take place would speedily die out. This condition reproduces the "critical mass" fea-

ture of the nuclear fission process. If the mass of uranium is below a certain amount, the number of neutrons which escape from it without colliding with a nucleus is insufficient to permit a chain reaction to develop.

Among the other exhibits there were few of markedly engineering interest. The British Thomson-Houston Company displayed a new type of cinema-studio lamp described as "a high brightness, colour modified, enclosed mercury arc." The colour modification was obtained by the introduction of cadmium into the mercury vapour. It is believed that the new lamp may eventually replace the carbon arc in cinema studios. It is silent, enclosed and prefocussed and difficulties in obtaining full-light output without delay on switching-on have been overcome. The lamp is made in sizes up to 10kW or more. A Technicolour film exhibited during the evening demonstrated the improved colour rendering obtained with the new lamp as compared with carbon arcs.

The National Physical Laboratory had an exhibit showing the changes in the coefficient of expansion of pure uranium. At normal temperatures the crystalline structure of uranium is orthorhombic. Along the three axes the coefficients of expansions over a considerable range are 3×10^{-5}, $-0{\cdot}3 \times 10^{-5}$ and 2×10^{-5}. On being heated to 680 deg. Cent., the element changes to β-uranium and on cooling reverts to the orthorhombic form. As it passes through this change pure uranium may develop very large crystals, the orientation of which controls the coefficient of expansion as measured in a rod of the metal. The exhibit showed the variation in the expansion of a rod taken through a series of heating and cooling cycles and illustrated the effect of warm rolling on the crystalline orientation.

Among the other exhibits we noted a differential analyser for the solution of a heat-flow problem (Imperial Chemical Industries), examples of synthetic crystals of rock salt and potassium bromide grown in this country for making optical parts for use in the infra-red region of the spectrum (Adam Hilger), a collection of fourteen microscopes made in the seventeenth and eighteenth centuries (the Wellcome Historical Medical Museum) and a precision machine for measuring stellar photographs to 0·001mm in each ordinate direction (the Cambridge Instrument Company).

The Institute of Metals

THE May general meeting of the Institute of Metals was held at the Institution of Civil Engineers, Great George Street, Westminster, S.W.1, on Thursday, May 22, 1947, under the chairmanship of the President, Colonel P. G. J. Gueterbock.

After the President had made some announcements, the following two papers were read and discussed together :—

THE MECHANISM OF THE EMBRITTLEMENT OF DEOXIDISED COPPER BY BISMUTH

By E. Voce, Ph.D., M.Sc., and A. P. C. Hallowes, B.Sc.

Synopsis

The mechanism of the embrittlement of phosphorus-deoxidised copper by bismuth has been studied and an explanation is advanced on the basis of the experimental evidence obtained. The mechanical properties of coppers containing up to 0·01 per cent bismuth have been determined by means of notched bar tests at temperatures up to 850 deg. Cent. and by notched bar and reverse bend tests after quenching from similar temperatures; the coppers tested by reverse bending contained up to 0·03 per cent bismuth. Embrittlement was also induced in copper by transfer of bismuth to the copper *vid* the vapour phase.

Bismuth contents as low as 0·001 per cent have been shown to cause some embrittlement of copper at temperatures between 450 deg. and 600 deg. Cent., although specimens tested at room temperature after quenching from this range only showed embrittlement when the bismuth content was 0·002 per cent or more. Both the degree of embrittlement and the range of temperature over which brittleness exists were found to increase with the bismuth content: the embrittlement was also influenced by the grain size of the copper, the efficiency of deoxidation of the original melt, the residual phosphorus content of the copper, and the presence of bismuth vapour in the annealing atmosphere.

The experimental facts lead to the conclusion that the agent responsible for embrittlement is elementary bismuth present in the form of a thin film at the grain boundaries of the copper, and that at temperatures above 600 deg. Cent. an increasing amount of bismuth passes into solid solution in the copper. From a consideration of the temperature at which the properties of bismuth-bearing coppers become equal to those of bismuth-free material, and the amounts of bismuth accepted from the vapour phase by a series of bismuth-free coppers of controlled grain sizes, it has been deduced that the solubility of bismuth in phosphorus-deoxidised copper increases from less than 0·001 per cent at 600 deg. Cent. to about 0·01 per cent at 800 deg. Cent.

A short summary is given of the factors influencing the permissible bismuth content under practical conditions.

THE MICROSTRUCTURE OF WROUGHT NON-ARSENICAL PHOSPHORUS-DEOXIDISED COPPER CONTAINING SMALL QUANTITIES OF BISMUTH

By T. H. Schofield, M.Sc., and F. W. Cuckow, B.Sc.

Synopsis

The brittleness of cold-worked non-arsenical phosphorus-deoxidised copper containing small quantities of bismuth after quenching from 550 deg. Cent. appears to be associated with films which are mainly present in the grain boundaries and are revealed by electrolytic polishing. Material quenched from 750 deg. Cent. is not brittle and does not show such films; brittle material showing films can be rendered ductile and free from films by quenching from 750 deg. Cent. The precise nature of these films has not been established, but it is probable that they consist of bismuth or a constituent containing bismuth.

Mr. E. A. G. Liddiard (Fulmer Institute) said that the work of Dr. Voce and Mr. Hallowes made it clear that the important factor controlling embrittlement by bismuth was grain-boundary absorption. He felt less sure about the evidence that the authors quoted for the increasing solubility of bismuth with temperature, though he agreed that it provided an explanation for many of the observed effects. There was a good deal of evidence from the transfer experiments that bismuth diffuses into copper much more quickly *vid* the grain boundaries. That being so, it ought to come out more quickly from the boundaries; and he was sorry that observations had not been made on the rate of extraction of bismuth from copper in which the bismuth was situated both at the grain boundaries and within the grains. Such experiments might be expected to show a change of rate when diffusion along the grain boundaries was replaced by lattice diffusion.

It was, however, about the authors' interpretation of the *rôle* of oxygen that he felt the greatest doubt. Excess oxygen minimises the effect of bismuth, but to prevent bismuth embrittlement a hundred times as much oxygen was needed as would be theoretically necessary for the formation of a sub-oxide of bismuth. This high excess of oxygen was, in his opinion, necessary in order to produce sufficient cuprous oxide to dissolve the bismuth, probably in the form of bismuth oxide which he still considered might be the embrittling agent. It was not impossible that maximum embrittlement might occur when the oxygen content of the copper was only one-ninth of the bismuth content. The fact that no transfer of bismuth to copper occurred in the presence of air (which would oxidise the vapour) was not at variance with the theory that oxygen plays some part. He thought it possible that the maximum transfer might occur at very low oxygen concentrations in the copper, but that in the complete absence of oxygen no transfer might take place, and that there would be no embrittlement. He thought that the authors' results did, in fact, show that the transfer of bismuth was rather more difficult under the conditions which were likely to be most free from oxygen. It was, he thought, significant that all attempts to effect a transfer from molten bismuth or from the vapour of molten bismuth had failed.

Mr. D. McLean (Armament Research Department) questioned whether the grain boundary films shown in some micrographs in the paper by Schofield and Cuckow were really responsible for the embrittlement, and also whether the appearance ascribed by Voce and Hallowes to thick grain boundary films of bismuth might not be due to etching effects. These doubts were suggested, on the one hand, by analogy with antimonial 70 : 30 brass, which also showed intergranular brittleness, but in which the intergranular precipitate formed did not appear to be the direct cause of the brittleness observed, and, on the other hand, by observations he had made of the surface contour of the antimonial copper alloys with an interference microscope. He agreed that the film, when present, was bismuth, but considered that there were alternatives to the intergranular-brittle-film explanation of the embrittlement.

Mr. G. L. Bailey (British Non-Ferrous Metals Research Association) said that, while the authors would probably agree quite frankly that their conclusions were not fully established, he thought that they were right in putting forward not only all the data, but also their own interpretation of the results. With reference to the part played by oxygen in the embrittlement of copper by bismuth, it would clearly have been very desirable to have been able to make some bismuth-bearing copper with oxygen of the order of 0·0003 per cent or less, but that could not be done. The diffusion of bismuth into copper and the embrittlement of copper by bismuth were two distinct questions, and even if it were established that the low rate of transfer of molten bismuth to copper was due to the absence of oxygen, and that oxygen was necessary for the transfer, it would not follow that oxygen was necessary to produce embrittlement by bismuth already in the copper. Mr. Bailey referred to the beneficial effect of phosphorus which might be attributed to the ability of phosphorus to remove oxygen, but at 550 deg. Cent. copper was always brittle when bismuth was present, whatever the phosphorus content might be. Lithium also had a profound effect on bismuth embrittlement, but this was not due to the fact that it was a better deoxidiser than phosphorus. The probable explanation of the effect of lithium was that it formed a lithium-bismuth compound $BiLi_3$, melting at 1145 deg. Cent., and if enough lithium were added, all the bismuth was tied up completely in this compound, leaving none in a condition to cause

embrittlement. He quoted figures to show the embrittling effect of bismuth on aluminium bronze containing 5 per cent of aluminium in the presence of which it was hardly possible to suppose that bismuth oxide could exist. For such reasons he could not sacrifice the authors' views for Mr. Liddiard's.

Dr. A. G. Quarrell (British Non-Ferrous Metals Research Association) described some experiments on the removal of bismuth from filings of phosphorus-deoxidised copper containing 0·1 per cent of bismuth by heating them in a current of hydrogen at temperatures of 750 deg., 850 deg. and 1050 deg. Cent. for various periods. To secure the sharp break in the extraction curve expected by Mr. Liddiard, it would have been necessary to use a lower temperature at which the rate of diffusion of bismuth through the lattice would have been small compared with that along the grain boundaries. At 1050 deg. Cent. the rate of lattice diffusion was appreciable compared with the rate of migration along the boundaries, and thus as soon as the bismuth was removed from the boundaries it was replaced by diffusion from the globules. Bismuth could be removed completely from copper heated for a sufficient time in a stream of hydrogen at a high temperature. He suggested that the authors' conclusion that there was a definite solid solubility of bismuth in copper, different for each temperature, might have been reached because they carried out their experiments under closely controlled conditions, so that there was in almost every case a similar concentration of bismuth on the outside of the specimen.

Dr. C. H. Desch recalled work on bismuth in copper, carried out with Professor Huntington over forty years ago, in connection with the brittleness of certain firebox stays. The curves connecting temperature with brittleness (as revealed by an alternate bend test) up to 1000 deg. Cent. were very much the same shape as those given by the authors. The embrittling effect was reinforced by the presence of selenium and tellurium, and the *rôle* of oxygen seemed quite important.

Mr. A. J. Murphy (J. Stone and Co., Ltd.), stated that the work referred to by Dr. Desch was carried out for his company, and that Professor Huntington's report had been made available to the research committee which was studying this question. To settle the issue between Mr. Liddiard who suspected that oxygen played an essential part in the mechanism of the embrittlement of copper by bismuth, and the authors who did not share that view, Mr. Murphy suggested that a few critical experiments should be made with gold. Mr. Bailey had reminded them how difficult it was to be sure, in any experiment made with copper, that oxygen was, in fact, absent. Gold was not reactive with oxygen, and if bismuth produced brittleness in gold, under the same conditions as the authors employed in their experiments on copper, we could be sure that oxygen was not playing a part.

Dr. J. C. Chaston agreed that experiments with gold would be interesting, but he doubted whether they would be as conclusive as Mr. Murphy had suggested. With molten bismuth the authors found no transfer of bismuth to copper, but he wondered whether, if the molten bismuth had already contained some copper in solution, some transfer would not have taken place.

Mr. A. Preece (Leeds University) suggested that the diffusion of bismuth from the inside to the surface of a heated specimen, noted by the authors, was due to oxygen in solution in the surface layer and might be accounted for by assuming that bismuth diffuses towards a region high in oxygen, just as, for example, sulphur diffuses towards the surface of a specimen of iron heated in an atmosphere of very low oxygen concentration, not sufficiently high to form iron oxide, but quite high enough to put oxygen into the metal. There were other examples of how one element can affect the diffusion of a second element in a solvent metal; and the beneficial effect of phosphorus and of oxygen on embrittlement by bismuth might be explained on similar lines, if the presence of oxygen or of phosphorus so increased the solubility of bismuth in the parent metal that it went from the crystal boundary into the crystal itself to a greater extent than before.

Dr. E. Voce, in the course of a brief reply to be supplemented more fully in writing, dealt with a few of the points raised. He said that the migration of bismuth to the surface of a specimen heated in air was due to its removal from the system as bismuth oxide. Phosphorus caused the bismuth to ball up at the corners of the grains. There was no evidence that either phosphorus or oxygen increased the solid solubility of bismuth in copper. The proposed experiments with gold, though worth doing, would not give comparable results, since gold formed a compound with bismuth and copper did not. It might be said that the embrittlement of gold was not caused by bismuth, but by gold bismuthide. He wished to correct the misapprehension that transfer of bismuth to copper could not be effected from molten bismuth. With an atmosphere of bismuth vapour or of hydrogen there was not good transfer; but when they had a boat of bismuth metal, put on that a lid of copper, wrapped the whole thing in foil and heated it up, they got a far greater transfer than with any other method.

Mr. F. W. Cuckow also replied, referring particularly to the electron microscope, in the application of which the important problems were replica technique and interpretation. A repetition of the work which was done three or four years ago would now probably produce further evidence. He wished to sound a note of caution, once again on the basis of interpretation, in connection with the interference microscope on the indications of which some of the remarks of Mr. McLean had been based.

The following paper was then discussed:—

INVESTIGATIONS ON THE EFFECT OF ZINC ON THE CORROSION OF SOME MAGNESIUM CASTING ALLOYS

By F. A. Fox, M.Sc.

SYNOPSIS

Corrosion tests have been carried out on unprotected magnesium 8 and 9·5 per cent aluminium alloys with varying zinc contents, both in high-purity and in normal-purity material; immersion in 3 per cent sodium chloride solution was mainly employed, but some atmospheric exposure tests were made also.

For the material of normal purity it was found that zinc additions were beneficial to the corrosion resistance as tested by immersion, provided that the zinc content was not appreciably below 0·4 per cent. It was not, however, of much value to add zinc in amounts much above approximately 0·5 per cent, especially in the case of fully heat-treated material, although for the as-cast and the solution-treated states, the higher zinc alloys were rather better than the lower zinc alloys.

In the case of atmospheric exposure, the varying zinc content of the alloys did not greatly affect the results, but the state of heat treatment had a different effect on the corrosion resistance from that during total immersion.

For the unprotected magnesium 5 per cent aluminium alloys of higher purity, the addition of zinc reduced the resistance to salt water attack.

Corrosion potential determinations were made on the alloys of higher purity, and it was found that the addition of zinc resulted in an elevation of the potential. It was concluded that the zinc reduced cathodic polarisation, probably by increasing the available cathodic area.

Mr. A. J. Murphy said that he found nothing controversial in this paper which demonstrated that while zinc was beneficial in low-purity magnesium it was harmful in high-purity magnesium; but he was not altogether happy about the inclusion of the results on the specimens in which the surfaces had been prepared with emery paper. He wondered whether it would not be better to disregard these results, looking on them as being vitiated by surface contamination with iron. It appeared that in the alloys of normal purity with 9½ per cent of aluminium a zinc content of 0·3 to 0·4 per cent (almost exactly the amount present in the alloy as used industrially) was a critical figure, and if it fell below this value there might be an increase in corrosion. He wished to emphasise again the very low figures for impurities in high-purity magnesium; 0·002 per cent was regarded as a critical iron content in some cases, though the critical iron figure was increased as the zinc content increased. In some of the alloys the iron content was only 0·001 per cent, corresponding to 1 part in 400,000 parts of magnesium by volume. Assuming uniform distribution, that was only 1 part superficially in 5000 parts. It was very striking that the effects of such small amounts could be so clearly delimited and also that technically it was possible to maintain that order of purity.

Mr. F. A. Fox stated, in reply, that he had tested the effect of emery paper against glass paper, pumice powder, &c., in immersion tests and found no significant difference. He thought therefore that there was justification for including these results in the paper. The critical importance of, say, 0·3 per cent of zinc in the alloys of normal purity had been recognised and the tendency was to raise the minimum zinc content.

Pulp and Paper in Canada

In many respects the past year was one of the most notable in the history of the Canadian pulp and paper industry. Not only did each branch of the industry—newsprint, pulp, fine paper, paperboard and wrapping-paper—attain new production levels, but the gross value of its production, exceeding 475 million dollars, makes the industry the largest individual contributor to the national income. Peacetime has accentuated the demand for newsprint. Production has risen from an average of 75·8 per cent for 1945 to a level that now exceeds 96 per cent of capacity. Even the wartime average was never in excess of 78·9 per cent of rated capacity on a yearly basis. But despite the increased production and exports, amounting to some 370 million dollars, the mills were not able to meet the demand abroad for pulp and paper. By the end of the first six months of 1946, production of newsprint had exceeded that in the like period of 1945 by 29·7 per cent, while shipments for that period showed an increase of 30·4 per cent. By the end of the year the mills had produced 884,184 tons more than in 1945. The newsprint statistics clearly reveal that, as compared with pre-war, the tonnage now available in the Canadian market has increased proportionately far more than in the United States. Canada is receiving virtually a third more newsprint than during the war years. Canadian publishers are much more favourably situated than those in any other country in the world. At the recent annual meeting of the Canadian Pulp and Paper Association it was announced that the industry, making ready to meet "reasonable levels" of world demands upon it, is planning substantial production increases for 1947 in practically all its branches.

L.N.E.R. West Highland Stations

RECENTLY we received the following particulars from the L.N.E.R. of new engineering works on the West Highland section of the company's lines, designed to assist in the development of the big Loch Sloy electric power scheme of the North of Scotland Hydro-Electric Board. When this section of line was constructed in 1894 the area was sparsely populated and only a single track was built. In the construction of the hydro-electric project difficulties arose in the transport of men and materials, as there were no stations or sidings in the vicinity to accommodate the traffic. The Hydro-Electric Board, in consultation with the L.N.E.R., decided that to overcome the difficulty two stations would have to be constructed at Inveruglas and Glen Falloch with additional accommodation for goods traffic at the former place, the station at Glen Falloch being used as a halt. In addition, a further halt had to be constructed at Faslane Junction near a prisoner-of-war camp, from which most of the labour was obtained in the early stages of the work.

Much goods traffic, including cement, brick, water pipes, steelwork and machinery used in the construction of the £4,500,000 project will be dealt with at Inveruglas, where excavations had to be made to allow for the construction of sidings to hold wagons conveying this traffic.

Facilities provided at Inveruglas, illustrated herewith, include a single platform of standard concrete slab construction with ash filling between the slabs. A goods loop to accommodate two engines, thirty wagons and van and a signalbox controlling the loop and siding signals had to be built, whilst three sidings were laid in to accommodate the contractors' traffic. The use of this type of platform permitted work to be carried out more expeditiously than would have been the case using ordinary walling, about 40 yards of platform being constructed completely in one weekend shift. The Glen Falloch platform is of similar construction. It serves for access to a roadway constructed by the Hydro-Electric Board in connection with aqueducts to be built among the hills above Loch Lomond as feeders to the main catchment area. At Faslane Junction the platform consists of a sleeper wall with ash filling. The standard concrete platform walls can be removed and used elsewhere in the event of the platform not being required once the scheme is completed.

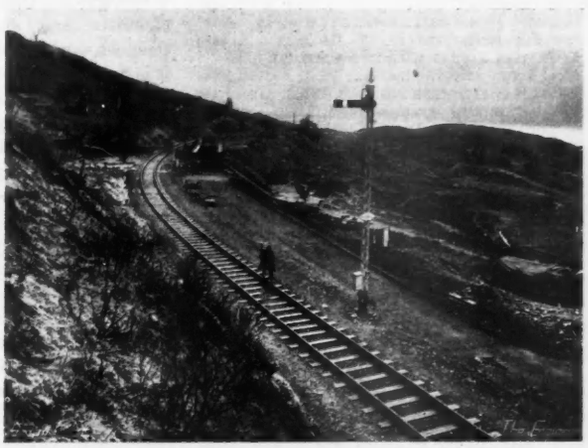
An engineering difficulty was encountered at Inveruglas, as pipes carrying the water from the tunnel from Loch Sloy down to the power station require to pass through below the railway embankment, involving the construction of a new bridge. Bridge construction during the operation of railway traffic would have involved imposing a very severe speed restriction while the work was in progress, as well as the construction of temporary service bridges over the excavation for the new abutments and wing walls. In order to avoid this dislocation it was decided to divert the line on to a temporary embankment on the west side of the site, as shown in an accompanying engraving, and so allow construction of the new bridge without interference to traffic. The length of the diversion was about a quarter of a mile.

The new bridge, which is illustrated herewith, was constructed by Sir Wm. Arroll and Co., Ltd., and consists of concrete abutments and wing walls with a steel superstructure of two main girders, cross girders and concrete floor, the clear span being 64ft. The whole of the work was carried out without interference to railway traffic and without imposing any speed restriction other than a nominal one for the safety of the men working in the vicinity.

This bridge is now in use and the diversion has been removed except for a portion at the north end, which has been left in as siding accommodation for the handling of the materials necessary for the construction of 7570ft of high-pressure pipe lines in connection with the hydro-electric scheme. A 10-ton crane is being erected to unload material at this siding.

The construction of the pipe lines is a major work in itself, and four pipes with outside diameters of 6ft 7in will be laid on the hillside between the outlet from the tunnel from Loch Sloy several hundred feet above the L.N.E.R. and carried through below the new bridge to the power station to be situated on the banks of Loch Lomond.

GOODS SIDINGS AT INVERUGLAS



RAIL DIVERSION AT INVERUGLAS

GIRDER BRIDGE NEAR INVERUGLAS STATION

AGRICULTURAL MACHINERY.—In a recent speech about home production of agricultural machinery, the Earl of Huntingdon, Joint Parliamentary Secretary to the Ministry of Agriculture, said that the monthly averages of the total production programmes for the year ending September 30, 1947, included combined corn and fertiliser drills, 100; tractor ploughs, 5000; sugar beet and root lifters, 175. Lord Huntingdon added that production difficulties might prevent the full programmes from being completed, but found it impossible to say how far short they might fall. Dealing with the position regarding spare parts, he said that he was not aware of any general shortage of spare parts for machines made in this country, though temporary and local shortages of individual parts might sometimes occur. In general, British manufacturers seemed to be fully alive to the need for an adequate supply of spares, and realised that they should be a first charge on capacity and materials. The main shortages had been of spare parts for machines of American make. It had been possible to arrange for some of these to be made in this country, but the range of individual spares runs into many thousands, and there were serious difficulties about producing some of them here.

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NOTICE TO READERS

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FUNDAMENTAL RESEARCH IN MECHANICAL ENGINEERING

IT is very appropriate that in the week immediately preceding that during which the Institution of Mechanical Engineers will be celebrating its centenary and in the very issue in which we review the history of that Institution and give some particulars of its centenary programme, we are able also to announce the setting up by the Government, through the Department of Scientific and Industrial Research, of a new research organisation. For that organisation, some particulars about which are given on another page of this issue, will be concerned with fundamental research in mechanical engineering and the chairman of the Board that will direct its activities is to be Dr. Guy, Secretary of the Institution of Mechanical Engineers.

In the past few years we have often been critical of the personnel of committees set up by the Government for engineering purposes on the ground that too much weight seemed to be given to scientific eminence and too little to engineering experience. Since the new organisation, in devoting itself to fundamental research stands in obvious danger of drawing too far away from the investigation of problems of real interest to industrial firms and of spending time and money on researches likely to prove only of academic importance, it is all the more welcome and comforting to find upon the Board that will direct its activities so many practical mechanical engineers. It will be observed, too, that, rightly, those who chose the members of the Board did not restrict themselves to the consideration only of mechanical engineers. There are representatives of civil and electrical engineering and of iron and steel technology, and men with particular knowledge of physics and chemistry. Fundamental engineering research to-day cannot be undertaken by single individuals. According to the particular problem that needs illumination, it is necessary to choose a team of investigators that may include physicists, chemists and specialists in other allied sciences working alongside engineers. Clearly it is desirable that the directing Board should have wide contacts outside the narrow limits of mechanical engineering. The Board so chosen seems well-fitted to direct the work of the new organisation. The field awaiting investigation seems very large, as those who attended or read about a number of conferences held within the last ten years by the Institution of Mechanical Engineers will be well aware. The Symposium on Some Modern Aids in the Investigation of Materials, Mechanisms and Structures of 1944; the Symposium on Surface Finish of 1945; Lectures on the Internal Combustion Turbine of 1946; the Conference on Machinability of last May; and the General Discussion of Lubrication and Lubricants, held as long ago as 1937, together with numerous papers presented in the intervening years, all certainly revealed that much technical knowledge exists upon which secure practice can be based. But they all indicated, too, some more obviously than others, that knowledge of the underlying reasons for the satisfactory or unsatisfactory performances of machines and materials is often lacking. Practice, in fact, is still often based upon experience obtained in experiments of the "trial and error" variety. No engineer, we hope, will ever condemn "trial and error" experiments. They have added greatly to engineering knowledge in the past and engineers will undoubtedly be indebted greatly to them in the future. But the more precise and more widely applicable knowledge to be gained from fundamental research promises not only to improve indirectly the efficiency and durability of engineering products, but to eliminate also the need for some of the "trial and error" investigation often now undertaken at considerable expense in default of any means of calculating beforehand from existing fundamental theory.

The new organisation was not set up without examination of existing facilities for engineering research in this country. The Committee of the D.S.I.R. that investigated the position knew, of course, that a great deal of such research is already carried out in Government establishments by industrial research associations and in the research laboratories and shops of engineering firms. But it found that in such establishments, tied more or less closely to individual industries or asked to solve the particular problems of individual firms, research tends to be too much confined to the solution of urgent immediate problems "to the neglect of fundamental or generic research on which mechanical engineering practice of the future may largely depend." Moreover, it was convinced by its visits to various research establishments and by its contacts with their directors, that to a very wide extent they all have common needs for theoretical knowledge on "subjects contributing to the basis of mechanical engineering science." The subject of supersonics, for instance, is not of interest only to builders of high-speed aircraft and to experts in ballistics. It may affect, too, steam and gas turbine and axial flow compressor blade design and it has an influence also on many other problems concerned with high speed motion or the flow of gases. The modes and effects of vibrations have repercussions on the design of almost all classes of machinery. Much is known about heat transfer in boilers, condensers, regenerators, and other stationary plant. But theoretical knowledge is still severely lacking where two contacting surfaces at different temperatures are in relative motion, a matter of obvious relevance in the design of all heat engines, and of much secondary machinery as well. Nor is very much known theoretically about the plastic flow of metals. The successful operation of presses, rolling mills and drawbenches is based upon the slow growth of practical experience, not upon much knowledge of the real factors involved. It approximates, indeed, more to an art than to a science. Nor as the Machinability Conference revealed, is the theory of cutting tools in satisfactory shape. We cannot even find an agreed definition as to what machinability means! None of these subjects, chosen as examples, is concerned, it will be noticed, with the immediate problem of designing a particular machine or operating a particular process. Each is of fundamental importance over a wide range of engineering practice. It is just such problems that it will be the object of the new organisation to study.

WATER POLLUTION

WE shall, we hope, be forgiven for referring at this time of year in a professional journal to so relatively a frivolous subject as angling. With holidays in prospect, thoughts of that sport have been present at the backs of our minds for some time. They have been brought out into the open by the publication last month of the report of the Water Pollution Research Board on its work between July 1, 1939, and December 31, 1945. For, to all those engineers who are also anglers—it is by no means an insignificant proportion—the word pollution brings to mind distressing memories of fish seen floating downstream belly upwards. But, of course, pollution of water has effects more important than that of depriving the angler of his pleasure, though where pollution of the tideway has prevented the running of salmon, the commercial loss is, in fact, by no means inconsiderable. The more important reason for requiring our rivers and waterways to be pure is that they act so often as the sources of water supply to large cities and that their condition is thus a matter of deep concern to water supply authorities. Only recently, it will be remembered, the Metropolitan Water Board in London has expressed anxiety about the present condition of the River Lea and the possible effects upon it of the creation of satellite towns in its

watershed. The purity of river water is, too, a matter of some concern to farmers, whose cattle are as subject to waterborne disease as human beings. Nor can the amenity value of rivers and waterways be wholly neglected. The polluted stream or river may easily become a danger to public health.

The Board is, of course, concerned to improve methods of purifying effluents and thus to prevent pollution. It has, for instance, much of interest to record in its Report about the purification of sewage. In particular, the experiments being carried out by the Board at Minworth in a large experimental plant placed at its disposal by the Birmingham Tame and Rea District Drainage Board on the process of alternating double filtration are attracting worldwide attention. For the process promises to permit very much higher rates of filtration for a given volume of filtering medium. Several disposal plants serving Government factories, of which the output was greatly extended during the war, were converted to the process with a resulting economy in labour and materials. Unfortunately, full details of their performances do not appear to have become available. Further work is to be carried out to obtain data on the working of plants operating upon stronger sewage and with more varying rates of flow than rule at Minworth. Much other work having an influence upon the operation of sewage works is mentioned in the report but must be passed over. For, in general, though the larger sewage works often have difficult problems to solve, it is seldom from their effluents that rivers are seriously polluted. It is the smaller plants, often unable to adopt more advanced methods, that have the greater difficulty in maintaining a high standard of effluent purity. Often, too, there is a difficulty in smaller plants in providing adequate supervision. The Board has recommended "that the methods of treatment applicable to sewage from small communities should be examined with the object of ascertaining whether any improvements are possible." But in many ways the more interesting part of the report is that concerned with the treatment of industrial effluents. For in the past such effluents, which are very varied in character and in polluting effect, were often poured with little or no treatment directly into streams or rivers. The lack of treatment arose far less through ignorance as to the damage that might be done or through wanton carelessness than through the lack of knowledge and of the means of acquiring knowledge of the processes that might be used to cleanse them. Unfortunately, it is still true to-day that there is often a grave difficulty in dealing with such effluents at an economic cost. The matter is becoming all the more important, in that with the spread of the electricity network there is less need than there once was for industries to congregate together. Industrial plants are already tending to spread to new areas and thereby tending also to make pollution more widespread. There is therefore wisdom behind the sentences in the report that "experience gained during the war has served to emphasise the importance of giving due consideration to the problem of the disposal of wastes before a site is selected and before the design of the factory is planned. . . . Unless this is done the factory, when in operation, may well find itself faced with very difficult problems."

Many years ago it began to be recognised that the legal and other means of preventing pollution were inadequate, and successive attempts have been made to remedy that state of affairs. In the last ten years, in particular, quite a lot has been done to place matters on a more satisfactory footing. The Public Health (Drainage of Trade Premises) Act of 1937, for instance, laid local sanitary authorities under an obligation to receive and dispose of industrial effluents in their districts, thereby tending to concentrate the work of purification into large well-superintended works rather than leaving it to be carried out as a very secondary operation by many individual firms. The operation of this Act has, of course, created special problems for disposal works, about which the Board has been much consulted. The Water Supplies and Sewerage Act of 1944 is likely to have some effect because it enables the Minister of Health and the Secretary of State for Scotland to help small authorities financially with the provision of adequate sewerage and disposal works. Lastly, there still remains to be put into practice the recommendation of the 1944 White Paper on "A National Water Policy" that River Boards should be set up to take over the functions of existing Catchment Boards, Fishery Boards and other authorities and become responsible for nearly all activities concerned with the *regimes* and conditions of rivers. The setting up of such Boards, by centralising in a single body many of the interests concerned with rivers, would, we believe, do much to aid those whose endeavour it is to prevent pollution and to undo, so far as it is now possible, damage that has already been done in the past.

Centenary of the Institution of Mechanical Engineers

No. I

AMONG the learned societies of this country the Institution of Mechanical Engineers occupies a very high place, and we feel it can be said that its centenary, which is to be celebrated in London during the coming week, is undoubtedly one of the major events of the year. During the last hundred years, phenomenal progress has been made throughout the world in the art and science of mechanical engineering—a fact that has been often stressed in these columns—and the centenary celebrations of the "Mechanicals" provide a fitting opportunity for tribute to be paid to the Institution for the contribution it has made to that progress.

The history of the Institution of Mechanical Engineers has been worthily recorded by Mr. R. H. Parsons in a centenary memorial volume which we hope soon to review. Nevertheless, it is appropriate to recall here the circumstances which led to the formation of the Institution. During the period of intense railway development in this country, in 1846, several mechanical engineers were present at some locomotive trials on the Bristol and Birmingham Railway. A heavy rainstorm compelled them to take shelter in a platelayers' shed, and whilst there they fell to discussing the possibilities of forming an Institution so that the problems and technical difficulties of mechanical engineers could be discussed to their mutual advantage. An ultimate result of this conversation was the holding of a meeting in January, 1847, at the Queen's Hotel, Birmingham, with Mr. J. E. McConnell, the locomotive engineer of the Bristol and Birmingham Railway, in the chair. At this meeting the constitution and rules of the Institution of Mechanical Engineers were adopted, George Stephenson was elected the first president, and about 107 mechanical engineers became members. Among the first vice-presidents were Mr. J. E. McConnell, Mr. Joseph Miller and Mr. Charles Beyer, who was the founder of the locomotive building firm of Beyer, Peacock and Co., Ltd. Mr. Archibald Slate was the Institution's first honorary secretary.

The list of original members contained many names which have an important place in the history of mechanical engineering, and significant amongst the original rules was one calling on each member to present to the Institution at least one communication a year tending to the advance of professional knowledge. The penalty of non-compliance with this rule was a fine of One Pound in the shape of a contribution to the library funds.

For thirty years the headquarters of the Institution remained in Birmingham, and then a move to London was made in 1877. The present home of the Institution, at Storey's Gate, St. James's Park, S.W.1, was built in 1899, additions being made to it in 1912. As well as the administrative offices, two meeting halls and committee rooms, it contains a library of over 35,000 volumes of technical and scientific interest.

During the first nine years of its existence, the membership of the Institution increased very little, but in 1856 the first summer meeting was held in Glasgow under the presidency of Sir Joseph Whitworth. This corporate visit to the provinces obviously stimulated wider interest in the Institution, and the membership increased more rapidly. It is well-known that in the succeeding years, the summer meetings in provincial centres and overseas have been a prominent feature of the Institution's activities.

It is naturally of interest to compare the present membership figures of the Institution with those of 1847, referred to above. In December, 1946, the total membership was 24,486, which included 3565 full Members, 10,452 Associate Members in Corporate Member classes, and 5288 Graduates and 4281 Students in the junior classes. The development of the Institution's organisation led to the formation, in 1920, of branches in the main geographical divisions of Great Britain. The affairs of these branches are controlled by local committees and the branch chairmen serve, during their term of office, as ex-officio members of the council of the Institution. In addition to nine branches in Great Britain, there are now three overseas. In 1930, H.M. King George V conferred a Royal Charter on the Institution, thus confirming

it in its work for the advancement of mechanical engineering science and practice, and permitting its corporate members to use the title "Chartered Mechanical Engineer."

The papers presented to the Institution in its early days were concerned mainly with new manufactures and methods of fashioning materials, and with descriptions of new kinds of machines and forms of prime mover. As time went on, however, the range of the subject matter was extended and it has become customary for papers and lectures to deal also with the more theoretical aspects of mechanical engineering science, and the properties of engineering materials and their testing. In the earlier years of the Institution, all the papers submitted were discussed at meetings, but as the volume of contributions has increased many papers are now published, which are discussed in writing, although, naturally, the verbal discussion at meetings is still regarded as a very important part of the Institution's work. Evidence of the importance attached to the meetings of the Institution—if it is needed—is provided by the fact that they were continued regularly in London and in the provinces during the air attacks in the recent war. Most of the papers then presented were published, though they were, of course, subject to censorship; but some of the wartime meetings were rather in the nature of "secret sessions" at the direction of the appropriate Ministry, on account of the matters discussed.

In addition to the discussion of papers on a variety of subjects, however, the Institution has encouraged the advancement of mechanical engineering science in many other ways, notable among them being the importance that it has attached to stimulating research. Since 1879, the Institution has followed a policy of conducting researches by its own committees and has also supported individual workers in their own researches. In this way, many significant advances in technical practice have been made. It is of interest to note that the first research undertaken by the Institution in 1879 dealt with riveted joints, whilst in more recent years, research work has been concentrated upon welding, high-pressure pipe joints, and high-duty cast iron.

Another part of the Institution's work which has become more and more valuable as the years have passed by is that dealing with technical education. Its own examinations ensure a high educational standard amongst mechanical engineers. Another important contribution to the education of engineers was made by the Institution in 1920, when in co-operation with the Board of Education, it instituted the National Certificate system of engineering courses and examinations. It is worthy of record that the number of candidates entering for these National Certificate examinations increased from 5454 in the last pre-war year of 1939 to 13,262 in 1945. This expansion included 1793 candidates for an engineering cadet course instituted by the Government, aided by the advice of the Institution, to provide officers for technical corps of the fighting services.

During the recent world war, the services rendered to the nation by members of the Institution were undoubtedly of inestimable value. Almost all of them were engaged, under the direction of various Government authorities, in the production of war material, or in research and development work designed to improve the fighting equipment of the Allies, and 140 gave their lives in the service of their country.

In this brief survey of the growth and development of the Institution of Mechanical Engineers, no mention has been made of the many distinguished men who have occupied the presidential chair since George Stephenson's day; nor has any detailed reference been made to the outstanding work in the realm of mechanical engineering which so many members of the Institution have performed both in peace and in war. But thoughts of these matters and of numerous other things pertinent to the work of this great Institution including the very recent amalgamation with the Institution of Automobile Engineers will be kept very much in the minds of all who participate in next week's centenary celebrations.

Although details of the celebrations have already appeared in these columns, many of our readers may like to be reminded of some of the more outstanding events. On Sunday afternoon at 3 p.m., there is to be a Thanksgiving Service at Westminster Abbey at which an address will be given by the Dean of Canterbury, The Very Rev. Hewlett Johnson, D.D., B.Sc., On Monday, at 3 p.m., the Centenary Celebrations will be officially opened by the Lord President of the Council, the Right Hon. Herbert Morrison, M.P., in the Great Hall of the Institution of Civil Engineers, Great George Street, S.W.1, and on Monday evening, at 8.15 p.m., Lord Dudley Gordon, the President of the Institution, will hold a Reception at the Science Museum, South Kensington, S.W.7. On Tuesday evening, at 8.30 p.m., the Clayton Lecture will be delivered at the Central Hall, Westminster, by Professor J. D. Cockcroft, F.R.S., on "The Possibilities of Nuclear Energy for Heat and Power Production," and at 9.30 p.m. there is to be a Reception by H.M. Government at Lancaster House. On Wednesday at 7.45 p.m., a Dinner Dance will be held at the Dorchester Hotel, Park Lane, W.1. On Thursday, at 8 p.m., the Parsons Memorial Lecture will be delivered in the Main Hall of the Institution by Sir Claude Gibb, F.R.S., a vice-president, whose subject is "Parsons—the man and his work." The Charles Parsons portrait will then be unveiled by the First Lord of the Admiralty, Viscount Hall. On Friday evening, at 7.15 p.m. for 7.45 p.m., the official delegates will go to the City for a Banquet at Guildhall, and there will also be an alternative function in the form of a Dance, with buffet supper, at 8 p.m., at the Connaught Rooms, Great Queen Street, W.C.2. On Tuesday, Wednesday, Thursday and Friday mornings, technical sessions for the presentation of a number of lectures will take place between 10.30 a.m. and 12.30 p.m., and the afternoons of those days are to be taken up by visits to many works and other places of technical interest in and around London.

A special mention must be made of two exhibitions which have been arranged as part of the centenary celebrations. The first is appropriately entitled "A Century of Mechanical Engineering" and will be opened at the Science Museum, South Kensington, by the Minister of Education, the Right Hon. G. Tomlinson, M.P., during the President's Reception on Monday evening next. The other exhibition will be one of more "domestic" interest to the members of the Institution for it consists of many objects intimately connected with the life of George Stephenson, the first president. This exhibition will be on view in the Institution building at Storey's Gate, St. James's Park, and will undoubtedly prove to be a specially attractive feature of the centenary celebrations.

(To be continued)

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

ROLLER BEARING EQUIPMENT FOR ELECTRIC STOCK

SIR,—The interesting article on the new Southern Railway lightweight electric bogies (THE ENGINEER, May 16, 1947) illustrates admirably the trend towards lighter traction equipment, the advantages of which will, no doubt, be reflected in improved performance and decreased track maintenance. In achieving these desirable ends it would appear that the latest practice in the traction field has been successfully followed, but it is a matter of comment that, in this advanced design, plain bearing axleboxes have been retained.

As is known, the use of roller bearing axleboxes is especially advantageous on suburban stock, since starting resistance is considerably decreased, thereby giving higher acceleration and/or decreased energy consumption. Additionally, from the operating angle, hot boxes are eliminated, a factor which contributes materially to availability of the rolling stock.

In connection with the foregoing it may be recalled that the later L.M.S. Liverpool-Southport electric stock, which, like the Southern Railway, operates on a running rail return system, is roller bearing equipped throughout and is presumably as liable to the likelihood of heavy current conditions as in the case of the new Southern Railway equipment. However, as far as the writer is aware, no trouble with the roller bearings due to such causes has, in fact, been experienced, although this L.M.S. stock has been operating for about eight years.

In such installations under normal conditions the return circuit for the equipment is from the motor through the motor suspension bearings and to the rail *via* the axle, so that the axlebox bearings are shunted. Attention may however, be called to the fact that, despite the considerations underlying the selection of plain bearings for this latest equipment, certain Continental and American railways have, in fact, successfully fitted an axle earth brush arrangement as an added precaution against the possibility of bearing damage due to heavy current conditions. This latter information is contained in a paper on roller bearing axlebox equipment, read before the Institution of Locomotive Engineers as far back as 1934.

R. HOWARD.

Huddersfield, May 28th.

INSTITUTION AMALGAMATION

SIR,—In your issue of May 30th you had an interesting suggestion in a letter written by Eric W. Denholm, suggesting institution amalgamation. This could be brought about very easily to start with by a simple scheme of co-operation, *i.e.*, the introduction of standard unbiassed analysis of our current scientific Press, run by all our institutions and sold to members and non-members on a loose-leaf basis at so much per sheet. The immediate knowledge of filing references from reliable sources to the current present and future developments and

activities of our country, the British Empire and, finally, the world, would be invaluable to everyone, and started on the right basis would soon be appreciated by all active personalities and organisations and would spread quickly, soon putting the scheme not only on an economic, but a profit-bearing, standard.

The central collecting organisation could be taken on by the development of the Aslib on its present lines, and it could eventually take on the comparison and reference to the best Colonial and then the foreign periodicals. It would only mean the addition of one or two intelligent brains to the staff of each institution to start with and work could develop at a stable rate, the best periodicals being dealt with and others added as time went on and the general interest spread. This would not be exactly amalgamation of certain of our institutions, but the result, on further developments later, would have the same effect, for the benefit of all concerned, the individuality of each public body being kept, which is an asset for each profession concerned.

The writer has run such a system for his own benefit on the headings of articles alone, and has found how useful this has proved, both to himself and friends in business, though only a few periodicals have been used and short time spent on it. The system used is so compact that reference to 20,000 or 30,000 pages can still be held in one hand, the sheets being 8in by 5in, and held in about six binding folders, which can be added to easily any time. The binding is on a spring or elastic system. A similar system for the filing of costs and outputs is used, 1000 sheets of varying lengths being housed in boxes, 17½in by 9in by 6in, by the use of binders and spring clips. It was started in 1922 and has been kept up to date since without trouble.

I am sure an institution could widen its field considerably and make its information of the greatest value, especially to those still returning from long periods of service to their country during the past war, who wish to get up-to-date information on their own and allied professions.

ARROL MOIR, Bart.

London, June 2nd.

SIR,—May I express appreciation of the way in which Eric Denholm and Christopher Bell have in their recent letters outlined an amalgamation proposal for the whole engineering profession.

By "closing" the profession, engineers will have gone a long way to putting engineering on a par with medicine and other established professions Many business executives will naturally raise objection to these proposals because they will have to start paying proper salaries. It is encouraging to see that the day is not far off when, like the B.M.A., the engineering profession will be speaking with one voice.

Much of the overlapping of examination syllabuses and duplication of fees will be eliminated by amalgamation, and I feel sure that the names of Eric Denholm and Christopher Bell are going to be closely associated with future institution activities. They are to be congratulated on their progressive ideas.

EUSTACE TRILLO.

Pinner, Middlesex, May 31st.

RAILWAY RECEIPTS.—In the four weeks ended May 18th, traffic receipts of the British main line railways and the London Passenger Transport Board amounted to £26,556,000, compared with £26,822,000 in the corresponding period of 1946. Passenger traffic accounted for £14,105,000, goods traffic for £7,937,000, and coal and coke traffic for £4,514,000. In the first twenty weeks of this year the total traffic receipts were £118,667,000, compared with £142,436,000 in the corresponding weeks of last year.

Mechanical Engineering Research

THE Government, through the Department of Scientific and Industrial Research, is setting up a special organisation to carry out scientific research in mechanical engineering to meet, and still more to anticipate, the needs of industry and Government Departments. The eventual annual expenditure will be in the region of £250,000 to £350,000, although it is unlikely that this figure can be reached for some years, because of the present difficulties in obtaining suitably qualified staff and buildings.

DETAILS OF THE NEW ORGANISATION

The research is intended mainly to supplement the research carried on in other research organisations in this country, and will largely be confined to those fundamental problems which underlie all mechanical engineering. Thus the subjects in which research is expected to be carried out are :—

(*a*) Properties and strength of materials.

(*b*) Mechanics of solids, stress, stability and vibration of structures.

(*c*) Mechanics of fluids ; aerodynamics, gas dynamics and hydraulics in their mechanical engineering applications.

(*d*) Lubrication, wear and mechanical engineering aspects of corrosion.

(*e*) Mechanisms, engineering metrology, and noise control.

(*f*) Mechanics of formation of materials ; machine shaping of materials.

(*g*) Heat transfer, heat exchange apparatus and applied thermodynamics.

THE DIRECTOR OF RESEARCH

Dr. G. A. Hankins, D.Sc., M. Inst. C.E., M.I. Mech. E., superintendent of the engineering division of the National Physical Laboratory, D.S.I.R., has been appointed director of mechanical engineering research.

As with all other research organisations in the D.S.I.R., the director will be advised by a board, consisting of eminent scientists, technicians and industrialists, serving in their personal capacity and not as representatives of any organisation to which they may belong. The composition of the mechanical engineering research board, which had its first meeting on May 22nd, under its chairman, Dr. H. L. Guy, secretary of the Institution of Mechanical Engineers, is as follows :—

Mr. L. Akehurst, of the London Passenger Transport Board ; Professor R. N. Arnold, Professor of Engineering, University of Edinburgh ; Dr. S. F. Dorey, chief engineer surveyor, Lloyd's Register of Shipping ; Sir Claude Gibb, C. A. Parsons and Co., Ltd.; Dr. H. J. Gough, engineer-in-chief, Lever Brothers and Unilever, Ltd.; Sir William Halcrow, President, Institution of Civil Engineers ; Mr. M. B. Hoseason, Brush Electrical Company, Ltd.; Dr. C. H. Lander, principal, Military College of Science ; Professor N. F. Mott, Professor of Theoretical Physics, University of Bristol ; Professor D. M. Newitt, Professor of Chemical Engineering, Imperial College ; Sir Ewart Smith, Imperial Chemical Industries, Ltd.; Professor H. W. Swift, Professor of Engineering, University of Sheffield ; and Dr. C. Sykes, F. Inst. P., director, Brown-Firth Research Laboratories.

LOCATION AND FORMATION

The site of the research station has not yet been decided. For the time being much of the work will be carried out at the National Physical Laboratory, while other work will be arranged for at universities and other institutions. The new station will work in close liaison with the N.P.L., which will provide the nucleus in due course of the new organisation. Unfortunately, no land is available close at hand for the building of the new station, which will require a considerable area.

ORIGINS AND FUTURE

The general plan and the early work of the new organisation will be based on the recommendations of a D.S.I.R. Committee on Mechanical Engineering Research, which reported on the essential needs for research in mechanical engineering, and examined in detail the mechanical engineering research facilities available throughout the country.

WORK TO BE UNDERTAKEN

As examples of the type of research which will be carried out under the headings above are mentioned :—

(*a*) The expansion of researches already in progress on the basic properties of materials at high and low temperatures and their application to design problems. The work at high temperatures is of great importance in increasing the efficiency of heat engines of all kinds ; the work at low temperatures has direct applications in the design of refrigerating machinery.

(*b*) General development and applications of elastic theory to mechanical engineering design ; also the building up of a research team fully competent and properly equipped to tackle the numerous vibration problems which arise in modern mechanical engineering.

(*c*) Detailed study and application of fundamental knowledge of fluid mechanics to mechanical engineering problems ; steam turbines and boilers and hydraulic machinery of all kinds are particular examples.

(*d*) A fuller understanding of the behaviour of lubricants, both mathematically and physically, not only in journal bearings but in oscillating motions and in gears ; and in co-operation with chemical research the development of improved lubricants.

(*e*) The basic science of kinematics and mechanisms, which is fundamental to the design of machine tools and production machinery of all kinds, has been neglected in this country ; it is hoped to remedy this position. Engineering metrology and accurate measurement is of very great importance in many branches of engineering and requires further development ; an important example is the measurement and assessment of surface finish of machined parts.

(*f*) The manipulation of engineering materials and the production of various components by pressing and shaping is still based almost entirely on practical experience ; the basic mechanics of this subject must be developed. Similarly a vast store of practical knowledge exists on the machining, shearing and cutting of engineering materials, but the basic mechanics or physics of these operations is still largely unknown.

(*g*) Problems in heat transfer are common to almost every branch of mechanical engineering and much further investigation is required, both in the basic science and in the application of existing knowledge to detailed design. Knowledge of thermodynamic properties of working fluids in heat engines and refrigerating machinery over a much wider range of temperature and pressure than is at present available is highly necessary for future progress.

OBJECTS OF ORGANISATION

The purpose of the new establishment will be to provide a convenient centre for the experimental work ; groups of research workers will be organised in each of the main branches and the necessary equipment, some of which will be on a fairly large scale, will be designed and installed. The research workers will be mainly engineer scientists, but will also include physicists and mathematicians. It is intended that in due course much of the work in progress will be well ahead of the immediate requirements of industry, and that the reputation and standing of the new establishment will be such that other research groups and firms will naturally turn to it for information and advice before starting on new projects. The manpower required for effective research in the various groups will vary because the research treatment of some of the subjects has still to be evolved, and the scale of effort required will

increase as they are developed. Close contact will be maintained with industrial research associations, since these provide a convenient way in which the results of fundamental and generic research can be made known and applied in industry. In the mechanical engineering industry there are a large number of firms which are too small to carry out much research for themselves and are not served by a particular research association; these firms, it is expected, will derive benefit from the results of the research to be carried out at the new establishment.

The evolution of a central establishment of this kind will take several years. In the interim period it is proposed to make the fullest possible use of existing facilities, particularly those at the National Physical Laboratory and in the mechanical engineering faculties of the Universities.

Pre-Fabricated Bus Bodies

A NEW technique in the construction of pre-fabricated coach and bus body skeletons with light alloy metals has been developed by the engineering staffs of four of the subsidiary firms of Tube Investments, Ltd.,—Accles and Pollock, Ltd., Metal Sections, Ltd., Reynolds Tube Company, Ltd., and Reynolds Rolling Mills, Ltd. These four companies have had long and specialised experience in the manufacture and application of steel tubes, cold rolled metal sections, "Hiduminium" light alloy extrusions, and sheet and strip, and the new technique has been evolved as a result of the pooling of their varied technical skill and knowledge. The new body skeleton consists of a combination of standard high tensile steel tubes and pre-fabricated cold rolled sections with extruded and rolled sections in "Hiduminium" light alloy with sheet panelling in similar material.

In the course of a recent visit to the firm's works at Oldbury, near Birmingham, we were able to see prototypes of the new bodies and their method of construction. The makers do not propose to build bodies themselves but to supply standard pre-fabricated parts for body building firms to incorporate into their own designs. No restrictions are imposed on the actual design of a bus frame as the pre-fabricated parts can be formed to suit various contours specified by the individual coach builders. All of the necessary parts for building the framing of a double-decker bus can be packed in a case 21ft long, 4ft 6in wide and 3ft high. These parts, it is claimed, can be erected into a skeleton ready for finishing by semi-skilled labour, in 22 man-hours for a double-deck framing and in 12 man-hours for a single-deck framing.

The following advantages are amongst the many claimed for the new technique: a saving of 20 per cent in weight as compared with similar wooden framing; a saving of at least 25 per cent in the time required for panelling; rapid repair in the event of damage, by the speedy removal of damaged sections and their replacement by standard pre-fabricated parts, and a minimum use of timber, which is in short supply.

The photograph we reproduce shows a section of a typical frame made by the new method. The general design is for standard sections which can be formed to various contours according to requirements, such as the type of chassis, seating plan, front or rear entrance body, and fixed or sliding roofs. All of the skeleton parts are supplied complete with the necessary gussets, brackets, &c., attached and precision drilled ready for assembly. In order to facilitate replacement in the event of damage the whole framing is designed as a rigid, bolted structure. Gussets are welded to steel parts only and no welding is effected in the light alloy components. High tensile bolts are used throughout for assembly purposes. Steel tubes are used for the highly stressed parts such as the pillars, and "Hiduminium" extruded sections for other structural members such as the cant rail, seat rail, garnish rail, &c. All steel parts are rustproofed by the phosphating process.

The main pillars are in chrome molybdenum steel 1½in square section tube and have welded to them pre-drilled gusset plates ready for the assembly of the waist rail, cant rail and the floor bar. This design eliminates need for the drilling of any structural holes through the tube for assembling the various components. The main floor bar of 0·35 per cent carbon steel is a channel section 2¾in deep by $1^{21}/_{32}$in wide by 10 gauge. A steel insert is spot-welded into position in the bar to accommodate the timber filling required for the attachment of the floor boards by wood screws. The bar is drilled to pick up the holes in the bottom gusset on the pillar and the floor member can be increased in depth up to 4in according to requirements. If specified, the floor bar

SECTION OF ASSEMBLED BODY

can be in the form of an extruded section designed to accommodate timber in the upper portion for the attachment of the floor boards.

An extruded tee-section seat rail is designed so that the seat rail brackets can be bolted directly to the web of the tee which extends inwards. This seat rail is fixed on the inside of the pillars and runs the full length of the vehicle.

An extruded section waist or garnish rail, which forms both a structural and a finishing member, runs the full length of the inside of the vehicle on the inside of the pillars and requires painting only for interior finish. It is bolted with special hank bushes to cruciform gussets welded to the main pillars. The bottom flange of the extruded cant rail is cut away to allow the pillars to extend through the upper flange. This rail also forms a structural and a finishing member running the full length of the body.

Roof sticks are supplied in the form of rectangular steel or "Hiduminium" tubes, or as extrusions designed to accommodate a timber fillet for fixing interior or exterior panels by means of wood screws. Brackets are welded in position and pre-drilled for bolting the sticks to the cant rail. When the sticks are supplied in the form of a tube the outside or inside panels are fixed by "pop" rivets.

The front bulkhead, which is made in two halves, is an all-welded steel tubular structure, strongly braced and having a 4in by 1½in chrome molybdenum main tubular member. The driver's cab is built up from steel tubing and can be of the half or full type.

All outside panels can be fixed with "pop" rivets to the tubular pillars, &c., as can be the pillar capping between the waist and cant rails, or the inside lining panel below the window.

The speed with which damaged sections of a body of this design can be removed and replaced by new sections was demonstrated by the makers during our visit. The conditions were, naturally, favourable, although the men giving the demonstration had had but little previous experience on this class of work. It was shown how two "pop" riveted panels and a pillar could be stripped right down and removed and then replaced in a matter of 27 man-minutes with a team of four men. The pillar itself, which weighed only 12½ lb, was replaced by one man alone in about 12 minutes. These pillars, which are rigid, are held in the main structure by fifteen high tensile bolts.

The framework of a single-decker bus body of this design, 27ft 6in long and 7ft 6in wide, weighs between 9 cwt and 10 cwt and for transport purposes five complete sets of body parts can be packed in two cases, having a total net weight of 45 cwt.

Pollution of Rivers*

Pollution and the Planning of Towns and Industries

During the war, when great changes occurred in the distribution of population and of industries, many problems arose in the disposal of domestic sewage and of industrial waste waters. Camps, frequently with their own sewage-disposal works, were established and there were large and frequent changes in the numbers of men and women accommodated. The construction of new factories, the extension of existing industries, and the introduction of new industrial processes, created many problems in the disposal of industrial waste waters. Under wartime conditions the choice of sites for factories was perforce often dictated by such considerations as those of security. Experience gained during the war has served to emphasise the importance of giving due consideration to the problem of disposal of wastes before a site is selected, and before the design of the factory is planned. Unless this is done the factory when in operation may well find itself faced with very difficult problems. For example, many types of waste water, possibly after some treatment at a factory, can be disposed of without much difficulty in admixture with the sewage of a town, but it might be both difficult and expensive to treat some of these waste waters to give an effluent suitable for discharge to a comparatively small river, which further downstream is used as a source of water supply or which is a valuable fishing stream. The report states that it is satisfactory to note that there appears to be increasing recognition of this general point and during the past few years many industrial firms have consulted the Laboratory before deciding on sites for new factories.

Sewage Disposal Work at Birmingham

Generally, only investigations of immediate importance could be undertaken during the war, but research was carried on continuously on the improvement of methods of treatment of sewage. The work was mainly on the development of methods which would reduce the amount of materials and labour required for the construction of new sewage-disposal plant or extension of existing plant. Expenditure on sewage disposal is largely unproductive, so that any method which reduces costs is welcomed by local authorities.

A most promising method developed by the Water Pollution Research Laboratory is that

* Summary of Report of the Water Pollution Research Board of the Department of Scientific and Industrial Research, 1939—1945.

known as "alternating double filtration," which in a large experimental plant at Birmingham has been used to treat sewage at three times the rate possible with the older method of single filtration. The effluents from the two processes are substantially of the same quality. The results of this development are that a considerably smaller plant, occupying less land, is required for the amount of sewage formerly dealt with. Another method being tried by the W.P.R.L. is filtration with recirculation of effluent. This process was originally developed forty years ago for the treatment of industrial liquors and has recently come into prominence again in the treatment of sewage. Sewage or industrial wastes can be treated by the process in biological filters at a comparatively high rate, and the method was used during the war in camps and factories.

The adoption of either of the two processes may reduce considerably the cost of construction where new municipal sewage-disposal works are required or where old works have to be extended or rebuilt. As an example, the cost of doubling the capacity of the bacteria beds at the Birmingham Tame and Rea Sewage Works at Minworth, near Birmingham, was estimated to cost £480,000. It has been decided to install alternating double filtration instead of the older process and the cost will now be £87,030.

Industrial Waste Waters

In the report many examples are given of research undertaken for the disposal of industrial waste waters. Among these are milk washings and whey washings from dairy and cheese factories; waste waters from the manufacture of smoke compositions, which give a bright red or orange colour to rivers and streams; waste waters containing chromate from such processes as leather tanning, chromium plating, and several other processes of treating metals; waste waters containing cyanide produced at factories engaged in electroplating with metals; waste waters from the manufacture of brake and clutch linings; waste waters from photographic processes, paper-mills, producer-gas plants, and from the manufacture of cellulose from sawdust, of beet sugar and of viscose rayon.

In some industries the development of methods of treatment of waste waters was undertaken not only to reduce pollution but to recover material which could be reused. An example is the treatment of waste washing waters from the pickling of copper. These liquids, although they contain only a small proportion of copper salts, can be treated economically in plant of simple design to yield sludge containing metallic copper, for which there is a ready sale.

Work at Coventry

One of the larger investigations was started in order to determine what the effect would be of chlorination of sewage effluents from Coventry. These effluents are discharged into the River Avon from two sewage-disposal works outside the city. It had been hoped to carry out an experiment on a large scale to determine the numbers and types of bacteria in the Avon below the points of discharge, during the first period in which the effluents were not chlorinated and then during a period in which chlorine was added. It was found, however, that addition of chlorine to the effluents made them highly poisonous to fish. It has been proved that this is due to the interaction of chlorine with constituents of gas liquors which are discharged to the sewers. The full-scale experiment has therefore not been carried out, but a detailed bacteriological survey has been made of the Avon under existing conditions. Although discharge of sewage effluents leads to a large immediate increase in the concentration of bacteria, the numbers fall rapidly below the points of discharge. At any given point in the river the numbers of bacteria per unit volume of water appear to be affected to a far greater extent by a small amount of pollution entering at a point a short distance upstream than by a larger amount entering at a greater distance upstream.

Treatment of Water

The report includes descriptions of several investigations of methods of treatment of water which were rendered necessary by wartime conditions. For example, chlorination of water was widely adopted as a safeguard in case polluting substances entered water mains damaged by bombing, and the Laboratory was asked to determine whether small concentrations of chlorine increased the corrosion by the water of taps, ballcocks and other fittings. Again, during the war it was impossible to obtain bitumen for coating pipes of cast iron and steel to protect them from corrosion, and many substitutes made from tar were tested to ascertain whether they would impart taste and odour to water under service conditions.

Mining Machinery, Electrical Plant and Oil-Firing Equipment

The Ministry of Supply issued on Tuesday last some information regarding the organisation which has been set up to speed up the production of heavy electrical plant, mining machinery and coal-oil conversion equipment. So far as the first two items are concerned, the Ministry's responsibility is to ensure as far as possible that manufacturers obtain all the necessary materials and components; to help manufacturers over difficulties with materials supplies, labour and the location of any necessary component capacity; and to progress orders so that deliveries are made as soon as possible. With regard to coal-oil conversion, the task of the Ministry of Supply is limited to the supply of equipment needed by the railways for the conversion of locomotives and the installation of oil storage depots.

The Ministry's new organisation is controlled by Mr. V. A. G. Lambert, Director-General of Armament Production. The reason for this title is, of course, that the Ministry of Supply was constituted to supply munitions for the Forces, and this is still its primary function, although many of its branches are now partly or wholly engaged in work of a civilian nature. Working under the control of the Director-General are a Directorate of Power Station Equipment, a Directorate of Mining Equipment, and a Directorate of Royal Engineer Equipment, part of which is specifically charged with the supply of coal-oil conversion plant. All the senior staff in these Directorates are experienced engineers, with first-hand knowledge of wartime production and progress methods. In addition to the establishment of the Directorate of Power Station Equipment, the Heavy Electrical Plant Committee has been reconstituted recently under the chairmanship of the Minister of Supply. Two meetings have been held already and such questions as materials supplies, sub-contracting, repairs, standardisation of plant, labour difficulties and export policy have been discussed.

The Ministry's new organisation will obviously have close relationship with other bodies, particularly the Central Electricity Board, the National Coal Board and the Ministry of Transport. In the case of electrical plant, it has been agreed that the Ministry of Supply will be responsible for programming and progressing orders, including raw materials, and for the clearing house work associated with the Heavy Electrical Plant Committee. The Central Electricity Board, however, will deal with the preparation of planned programmes, specification, design, ordering of plant, and will also specify target commissioning dates.

The Ministry's relationship with the National Coal Board falls into two parts—programmed and non-programmed equipment. The first consists mainly of coal-face machinery and conveyor belting. The National Coal Board notifies the Ministry of its demand over various periods, and arrangements are then made for the translation of those demands in a production programme with appropriate manufacturers who must negotiate sub-contracts if the capacity of any particular firm cannot meet the Board's full requirements. The National Coal Board, as the users of the equipment, will naturally give full specifications for its requirements and will place orders against the production programme arranged by the Ministry of Supply. With regard to non-programmed equipment, the individual production units of the National Coal Board have placed or will be placing their orders direct with manufacturers for this equipment, which consists largely of machinery designed for special use in particular places. The Ministry of Supply will keep in touch with these manufacturers and will be responsible for progressing any sub-contracting necessary and for supplies of raw materials.

In coal-oil conversion, the Ministry of Transport is the co-ordinating planning department for all matters concerned with the railways, and the Petroleum Board is responsible for the supply of tank wagons and for the construction of the bulk fuel oil ground installations. The Ministry of Supply is kept informed of the progress in site preparation and can regulate the supply of new equipment accordingly.

The Ministry of Supply also gave some particulars as to how the new organisation is tackling its problems. The Government has instructed that the highest priority shall be given to the provision of raw materials and skilled labour for the production of heavy electrical equipment, but a major difficulty is the shortage of electric sheet steel, the current output of which covers little more than half the total demands from all users. Responsibility for obtaining supplies of steel has now been centralised in one branch and agreement has been reached with the Iron and Steel Board on machinery for identifying and progressing priority orders. As to production targets for heavy electrical plant, it is hoped that by 1953 or 1954 all plant more than twenty years old will have been replaced. On the average, in the period 1947–54, the new plant required annually to meet the growth of loading and replacements will be approximately 1,400,000kW. Total production in 1946 of turbo-alternators for home and export orders was 810,000kW. A comprehensive review of exports is being undertaken and manufacturers have agreed to consult the Ministry of Supply before accepting further orders for steam turbo-alternators of 10,000kW capacity and over, hydraulic turbines costing £100,000 or more, and water-tube boilers of 10,000 lb per kW capacity and over.

Similar steps in the provision of raw materials and labour are being taken with regard to the production of mining machinery. The National Coal Board is arranging for identification of its orders by a special certificate, so that manufacturers will have no doubts as to whether or not a particular order is required in the drive for coal production.

Coal-oil conversion has equal priority with the supply of heavy electrical plant and mining machinery. The railway companies' programme envisages the completion of ten ground storage stations by the end of July, forty-nine by the end of October and fifty-eight by the end of the year. Completion of this programme depends upon the supply of equipment by the Ministry of Supply and the progress made by the railway companies in preparing sites and installing the equipment. The railway companies have been obliged to design each storage and pumping depot individually to suit local ground and traffic conditions and standardisation to any large extent has been impracticable.

Demonstration of Rail Bonding.—A demonstration of the oxy-acetylene method of welding copper bonds to rails was held recently at the Prescot works of B.I. Callender's before Mr. C. M. Cock, chief electrical engineer of the Southern Railway, and Mr. R. J. Harvey, consulting engineer. The demonstration included the welding of two types of rail bonds, each of 0·35 square inch cross-sectional area, to a 95 lb per yard running rail, after which the bonds were subjected to microscopic examination and hardness and electrical tests.

High Creep Strength Austenitic Gas Turbine Forgings*

By D. A. OLIVER, M.Sc., F.I.M., F. Inst. P.,† and G. T. HARRIS, M.A., F. Inst. P.†

No. II (*continued from page 469, May 30th.*)

Secular Changes in G.18B and R.20 Steels

In connection with the use of turbines designed for long lives, it is important to know what changes in mechanical properties occur when the steels are held at temperature for extended periods. Tests have been carried out on the ageing of G.18B for periods up to 4000 hours and for R.20 up to 1000 hours. Fig. 3 shows the change of impact strength of G.18B on soaking at temperatures between 650 deg. and 750 deg. Cent. for periods of up to 4000 hours. It is clear that the impact values fall fairly rapidly and become asymptotic to a level of about 15ft-lb. The same results plotted on a logarithmic time scale in Fig. 4 indicate that a minimum value of the impact is reached at about 2000 hours at 700 deg. Cent., and that about the same minimum is reached for shorter times at higher temperatures. Similar results are obtained on tensile testing, and Fig. 5 shows the changes in percentage elongation values plotted on a logarithmic time scale. The properties for one temperature, namely, 700 deg. Cent., are plotted together in Fig. 6, which shows that as the ductility and impact values decrease, the proof stress and maximum stress of G.18B tend to rise. Similar curves for R.20 steel at 700 deg. Cent. are shown in Fig. 7, from which it will be noticed that there are very small changes in properties up to 1000 hours. Detailed further information on G.18B cold tensile tests after ageing at other temperatures are given in Table III.

Table III.—*Long-Time Ageing Experiments on G.18B*

Ageing.		Cold tensile test.					
Temperature, deg. Cent.	Time, hours.	0·1 per cent P.S., tons per sq. inch.	0·2 per cent P.S., tons per sq. inch.	M.S., tons per sq. inch.	Elongation, per cent.	Reduction of area, per per cent.	Cold Izod, ft-lb.
	0	16·2	18·0	44·8	46	51·0	50·0
650	32	16·3	18·3	46·3	43	50·0	49·1
	69	15·9	18·2	46·0	43	50·0	47·0
	125	15·5	17·6	45·0	45·5	51·0	(59·0)
	280	16·5	18·7	46·2	37	44·8	41·2
	512	17·0	19·5	47·0	39	43·0	38·0
	1016	18·3	20·5	48·0	34·5	36·0	30·0
	2004	22·5	25·0	52·6	28	31·0	23·0
	4096	21·1	24·5	55·2	26	27·5	18·8
700	32	16·6	18·7	46·2	41	44·8	50·6
	65	16·3	18·4	46·0	41	46·0	40·8
	128	16·6	19·1	46·4	39	44·8	38·8
	280	18·1	20·5	47·6	33·5	38·0	29·0
	511	20·0	22·7	50·0	29	33·6	24·5
	1024	19·7	22·9	52·6	27	28·5	18·4
	2082	21·1	23·8	54·6	23·5	22·5	18·6
	4096	19·7	22·5	54·4	27	31·0	18·8
750	32	16·4	18·8	46·2	35·5	40·6	33·0
	64	17·8	20·4	46·2	32	39·0	28·6
	128	18·1	21·0	49·4	24*	15·2*	22·5
	256	19·1	22·5	51·4	26·5	27·6	19·7
	512	18·5	21·4	51·0	15*	15·2*	18·5
	1024	17·8	20·8	52·0	24·5	22·0	17·2
	2060	19·3	21·7	51·8	27	29·0	17·8
	4200	18·2	20·9	50·8	26·6	27·2	14·5
800	32	18·9	21·3	46·8	35·5	37·0	29·5
	64	19·6	22·0	48·6	31·5	31·0	22·5
	128	19·9	22·7	49·5	22	16·5	14·8
	263	18·6	21·3	48·2	27*	22·5*	17·6
	508	20·3	22·9	50·0	19*	17·0*	16·2
	1048	17·9	20·4	48·8	22*	16·5*	12·5

* Broken outside gauge length.

As a further check on the effects of long-time ageing on the mechanical properties, tests have been carried out on the hot fatigue strength of G.18B. The results of these tests are given in Table IV.

These tests were carried out on the Wöhler type of fatigue machine. The temperature of test of 650 deg. Cent. may actually be in error by 10 deg. Cent., but was definitely the same for both series of tests. The tests show that the hot fatigue strength has been, if anything, raised by the ageing treatment, and therefore follows fairly closely the effects on the proof and maximum stresses. Thus there is definite evidence against lowering of ductility being accompanied by a decrease in hot fatigue strength.

The results of stress-to-rupture tests at high temperatures also indicate that even under the combined effect of stress and temperature the ductility does not decrease with time. For instance, the elongations at rupture of the five points recorded in Fig. 1 for G.18B are given in Table V, and it will be seen that under creep conditions there is a definite tendency for the percentage elongation at rupture to increase as the rupture time goes up from 22 to 3000 hours.

The Use of Creep Data as Applied to Solid Rotor Forgings

It is not difficult to realise that very considerable time, effort and equipment are involved in mapping thoroughly the characteristics of a given material for use at high temperatures, and thus the number of alternative test conditions is severely limited. The tests on G.18B recorded in this paper refer to steel of typical composition in bar form rolled from billet, which, in turn, was hammer cogged from the ingot. Naturally, steel subjected to this degree of hot working is likely to be of more uniform structure than that of a forging worked direct from the ingot with a cross-sectional reduction of area of the order of only 2½ to 1. This limited forging reduction has been imposed to limit ingot size, as it is more important to have a small sound ingot than a larger ingot with axial porosity. A further limitation arises on account of the ability or otherwise to heat-treat the complete forging at the highest desirable solution temperature. Reduction of properties due to this factor can be estimated from the curve given in Fig 2. The result may well be that the creep strengths of the periphery of the drum of a rotor forging are lower by between 10 and 30 per cent of the properties given in the tables and curves.

In estimating the working stress to be imposed on the rotor drum at the blade roots, it is common practice to estimate the stress-to-rupture at 10,000 hours, 50,000 hours or 100,000 hours, as the case may be, and then to fix a working stress ranging between 0·6 and 0·9 of this value according to the factor of safety desired or the margin which the adoption of the material permits from an engineering point of view. However, these matters are still in a rapid state of development, and it is not proposed to attempt to lay down dogmatically any design rules, as the judgment of the designer is paramount in this connection.

Table IV.—*Hot Fatigue Tests on G.18B Steel at 650 deg. Cent*

Stress, tons per sq. inch.	Solution treated 1300 deg. Cent.	Solution treated 1300 deg. Cent + 1000 hours 700 deg. Cent.
	Reversals.	Reversals.
±26	—	6,800 broken
±24	—	40,000,000 unbroken
±22	19,800,000 broken *	40,000,000 unbroken
±21	—	42,000,000 unbroken
±20	42,500,000 unbroken	42,000,000 unbroken
±19	—	40,000,000 unbroken
±17	—	40,000,000 unbroken

Table V.—*Percentage Elongation at Rupture of G.18B Steel* Temperature of Tests, 700 deg. Cent

Stress, tons per sq. in.	Time to rupture, hours.	Elongation at rupture, per cent.
19	22	7·4
17	44	6·2
15	145	10·2
12	740	12·0
10	3000	15·0

General Observations on the Long-Time Testing of Materials at Elevated Temperatures

It would have been gratifying to the authors to have been in a position to include comprehensive data on actual gas turbine components. However, the ordinary room-temperature mechanical properties obtained from four large rotor forgings in different steels are given in Table VI. Tests taken tangentially and radially from rings trepanned adjacent to the rim are recorded, and show the variations likely to be encountered due to variations in the degree of forging. However, it must be freely stated that it will be several years before complete creep information is likely to be available and only then if much discipline and foresight are exercised in planning experiments and recording actual plant performance.

Laboratory creep tests on standard steels should be conducted for at least two years to prove that present extrapolated stress values are truly valid. Moreover, the observations should be repeated in part on actual rotor material to secure a precise basis for future designs and any service comparisons. Long-time hot fatigue tests are also desirable with and without special atmospheres surrounding the specimens. Information of this type is at

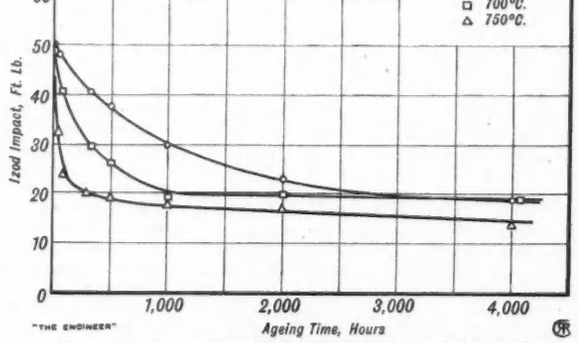


FIG. 3—*Secular Changes in Cold Impact Strength of G.18B Steel with Ageing (Linear Time Scale)*

* Institute of Marine Engineers, April. Abstract.

† The Research Department, William Jessop and Sons, Ltd., Sheffield.

present almost entirely lacking. Studies on secular changes and their effects on different characteristics need to be continued and extended.

It is inevitable in the present state of knowledge of gas turbine materials that for some time to come designers will have to work on limited data and to consult their metallurgical advisers for estimates of "risk." The present trend is for a relatively few special steels and alloys to be employed by a large number of gas turbine manufacturers. This has the advantage of narrowing the field of inquiry and enabling fuller data to be secured quickly, but conversely it implies that any unsuspected deleterious characteristics are liable to affect a large number of users. The utmost encouragement should be given to the provision of more high-quality creep and fatigue testing laboratories as the tasks lying ahead appear immense. It is easy to occupy a complete laboratory for years with one material in one initial state of heat treatment.

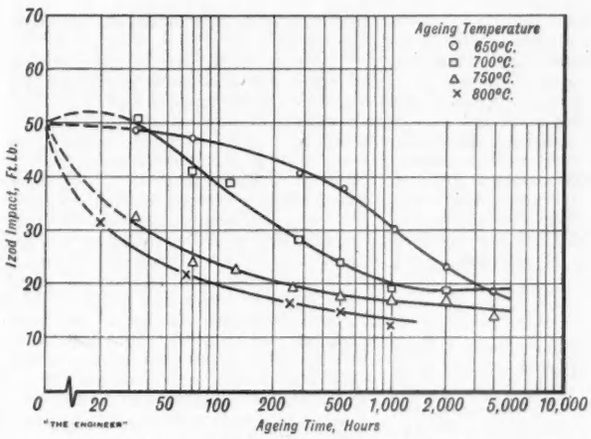


FIG. 4—*Secular Changes in Cold Impact Strength of G.18B Steel with Ageing (Logarithmic Time Scale)*

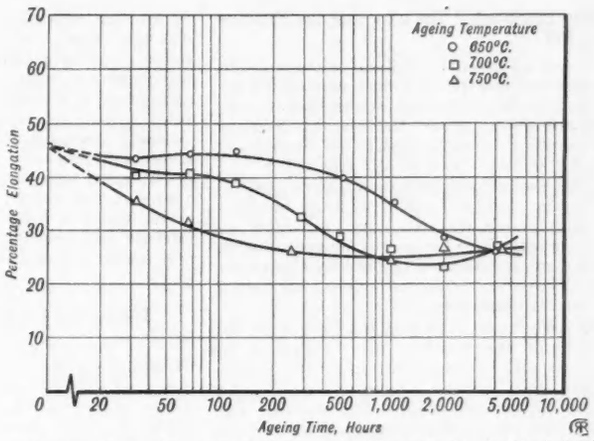


FIG. 5—*Secular Changes in Cold Percentage Elongation ($L=4\sqrt{A}$) of G.18B Steel with Ageing*

The Present State of Gas Turbine Development from the Metallurgical Point of View

Unlike aircraft jet engines, where the rotor blades operate at 30–50 deg. Cent. above the blade root disc rim temperatures, the axial flow land and marine gas turbines operate with blades and rotor drums at very nearly the same temperature. Thus the advent of a newer rotor blade material while very significant in the first case is less so in the second.

Assuming therefore that there is no appreciable temperature difference, it would appear that the present maximum temperature of operation would lie in the 700–750 deg. Cent. range so far as solid forged rotors and their blades are concerned. An operating temperature of this order does enable overall thermal efficiencies of over 34 per cent to be achieved, and thus makes the gas turbine competitive with its steam counterpart.

Development of new alloys along orthodox lines will probably enable these operating temperatures to be raised eventually to about 850 deg. Cent. This development will probably take about another five years. For temperatures higher than 850 deg. Cent. it is probable that built-up constructions will be resorted to because of the extreme difficulties in manufacture of large rotors in these creep-resisting materials, and because it is obviously uneconomic to provide a large mass of steel, of which, say, only one-tenth need resist the highest combinations of stress and temperature. With intensive research and development, such built-up rotors should be available within the next ten to fifteen years, with drums that can run at temperatures of the order of 950 deg. Cent. After fifteen years it is possible that the emphasis on the operating temperature requirements will change, but if efficiencies then demand still higher working temperatures, these efficiencies are likely to be achieved by the use of hollow components internally cooled.

The newer problems of utilising the vast heat energy generated in atomic energy "piles" may be solved eventually by leading heated gases under control to gas turbines of suitable type. The gas turbine may then be the principal prime mover on land, sea and in the air.

TABLE VI.—*Mechanical Properties of G.18B and R.20 Rotors*

Rotor.	Steel.	Direction of test.	0·1 per cent. proof stress, tons per sq. inch.	Maximum stress, tons per sq. inch.	Elongation, per cent.	Reduction of area, per cent.
1	G.18B	Longitudinal Tangential Radial	18·2 16·8 —	42·4 40·0 42·8	45 33 31	50 31 31
2	G.18B	Longitudinal Tangential Radial	18·8 17·3 —	44·0 36·8 39·4	41 19 17	47 18 —
3	G.18B	Tangential Radial	17·0 —	37·2 39·7	16 20	15 18
4	R.20	Longitudinal Tangential Radial	13·3 12·7 —	35·2 34·0 36·1	54 41 43	60 39 35

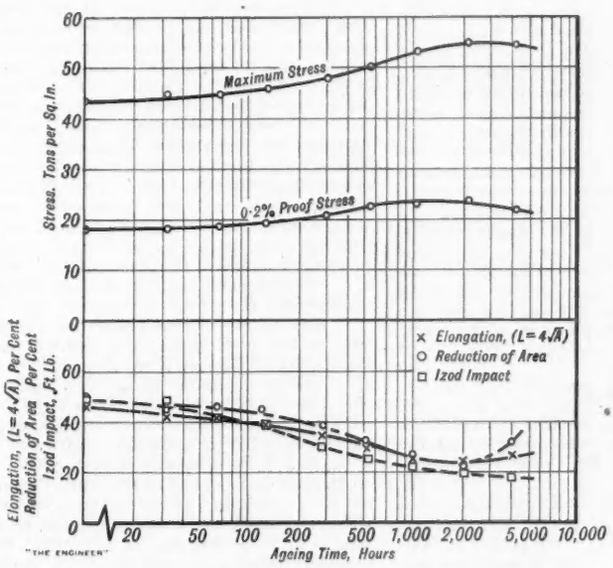


FIG. 6—*Secular Changes in Cold Mechanical Properties of G.18B Steel with Ageing at 700 deg. Cent*

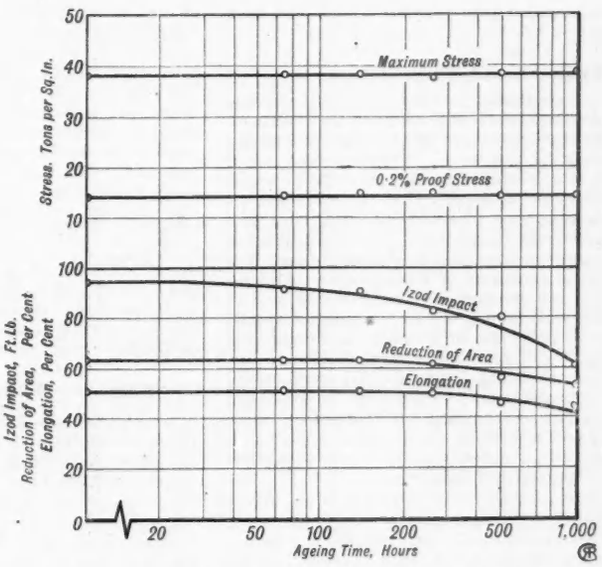


FIG. 7—*Secular Changes in Cold Mechanical Properties of R.20 Steel with Ageing at 700 deg. Cent*

Industrial and Labour Notes

The Engineering Industry and the Finance Bill

A statement of opinion concerning the provisions of the Finance Bill was issued by the Engineering Industries Association at the end of last week. It says that the Bill does not give the engineering industry the encouragement for which it had hoped and which had been sought through representative associations. The deterrent effect of high taxation upon production and efficiency, a matter so forcefully emphasised in many quarters during recent months, has been ignored by the Chancellor in his determination to extract maximum taxation from industry.

The Association expresses the view that the retention of the standard rate of tax at 9s. in the pound, the continuation of the profits tax with its "vicious" increase to 12½ per cent on distributed profits, and the new tax at 10 per cent on bonus issues, all represent undisguised attacks on the profit motive which augur ill in a community which has founded its destiny on the enterprise and efficiency of its members. It is typical of the reckless and anomalous nature of the new legislation, the statement goes on, that the full burden of the augmented profits tax on distributions should fall upon the profits available to the equity shareholder whose capital is the financial life-blood of industry, and who provides funds for research and development into new and extended fields.

Similar comments are made in the statement about the new tax on bonus issues which, the Association feels, seems to be based upon a gross misconception of an elementary accountancy principle. It is clear that the Chancellor wants profits to be ploughed back or retained in industry and not distributed to those who the Association claims, are surely entitled to expect a reasonable return on capital invested. The surest method of converting undistributed resources, in the form of reserve funds or capital profits, into permanent and undistributable capital, is by the conversion thereof into bonus shares. It is this very form of transaction, the Association points out, which the Chancellor of the Exchequer now chooses to tax on the pretext that it may form the basis of certain Stock Exchange manipulations which are not relevant to the finance of industry itself. The new tax is not even levied on the recipients of that profit to which the Chancellor takes exception, but upon the company, which is the innocent party to such transaction, and on a basis which involves a liability uncertain in its amount until after the issue has been made.

Capital, Management and Labour

Addressing the recent annual meeting of John Summers and Sons, Ltd., the chairman, Mr. R. F. Summers, referred to the present-day tendency to forget that industry really consisted of a combined operation of the principal forces involved, namely, capital, management and labour, each of which played a vital part in its own specific sphere. Under the difficulties and complications which existed to-day, the successful functions of management called for the highest qualities of ingenuity and tact in dealing with human nature, in addition to the accepted principles of technical and organising ability. Talking of his own company, Mr. Summers said that, not only did it try to ensure that managers and foremen were in possession of the greatest amount of information as to policy and difficulties which had to be met, but it also did all it could to extend this principle to the operatives themselves.

Consideration of the remaining force in the combined operation—capital—did not mean, Mr. Summers continued, merely the issued capital as shown in the balance sheet, but the total amount employed in running the business, which, of course, was a substantially higher figure—an important point, and one which was very often overlooked, especially when considering the rate of dividend paid. This, Mr Summers remarked, was usually quoted as a percentage of the issued capital, whereas if the total amount of the capital employed in the business was taken into account the figure was considerably lower. The position of industry, he thought, was very aptly summed up by a prominent American many years ago, who, when asked which was the most important partner in it, replied, "You tell me which is the most important leg of a three-legged stool."

The Export Drive

A simple explanation of the United Kingdom's export and import trade has been prepared for the Board of Trade by the Central Office of Information, and has now been published by H.M. Stationery Office (price 4d.) under the title "We Live by Exports."

The booklet surveys very concisely the well-known facts of this country's export and import position, and the information presented is made more readily understandable by the various charts which are included. The final section of the booklet points out that by the end of 1946 this country had already reached and passed its first target by producing exports at the rate of 112 per cent of the 1938 volume, and adds that "we were doing well till the fuel crisis and the weather of early 1947 set us back very seriously."

Emphasising again the country's need to build up its export trade as quickly as possible, the booklet comments that our industries must be re-equipped for greater production, as "the higher our total production, the easier we shall find it to fulfil the demands of the export trade."

Private Trade with Japan

The Board of Trade has made certain Orders, the general effect of which is to permit trade in goods and transactions incidental thereto with the Japanese State and with private traders carrying on business in Japan. Japanese money and property in the United Kingdom at the date of the Orders, and income arising therefrom, continue under Board of Trade and custodian control. The issue of the Orders is in line with similar action taken in the U.S.A. after consultation with the U.S. military authorities in Japan.

It is pointed out, however, that the relaxation of the United Kingdom trading with the enemy restrictions in respect of trade with Japan in no way affects the need for complying with all relevant rules and regulations in force in Japan. The purpose of the issue of the Board of Trade Orders at this time is to ensure that when normal trading relations with Japan become possible, no legal impediment will remain in the way of United Kingdom traders who wish to trade with Japan. Furthermore, the policy of the military authorities of not allowing the admission of business men into Japan remains in force. As soon as economic conditions permit, this policy will be relaxed and to this end a list of business men, willing to visit Japan at the first opportunity, is being compiled by the Export Promotion Department of the Board of Trade.

Where Do We Stand?

The June issue of *The District Bank Review* contains an extensive survey of the economic situation by Mr. Oscar R. Hobson, entitled "Where Do We Stand?" In it Mr. Hobson says that it would be a mistake to regard our present situation as purely the outcome of coal shortage. There are other serious shortages of material besides coal—timber, hides, copper, lead, linseed oil, for example—and these, he suggests, will bulk more largely in our consciousness as the extreme coal shortage abates.

These shortages, Mr. Hobson continues, are all symptoms of a single malady of monetary origin, generally known as inflation. Considered absolutely, resources are always scarce, and in a practical world it is only useful to consider supplies of goods in relation to what is called effective demand, that is, demand backed by the possession of "purchasing power." In a free economic system, shortages of supply will quickly disappear through the operation of rising prices which will, on the one hand, evoke additional production, and, on the other hand, limit demand. Free movement of prices, Mr. Hobson observes, whether or not assisted by monetary control, will automatically restore balance to an economic system; it will eliminate bottlenecks and shortages by methods which the modern generation would consider Procrustean and ruthless, but which, nevertheless, are effective.

Later in his article Mr. Hobson discusses this country's financial position and in this connection mentions the disastrous effects of the fuel crisis upon production. It is doubtful, he says, whether industry is even now working at more than 85 per cent of capacity, thus implying a degree of under-employment of labour which over the whole of manufacturing industry may well be equivalent to an unemployment roll of a million and a quarter.

Railway Wages

Representatives of the railway trade unions have recently met the Minister of Labour and the Minister of Transport to discuss matters arising from negotiations for better wages and conditions. These negotiations concern workers in the traffic, locomotive and clerical grades, and include chiefly a claim for an all-round increase in wages of £1 a week. It is understood that the N.U.R. and the Associated Society of Locomotive Engineers and Firemen also want for their members a forty-hour week instead of the forty-eight hours at present worked, whilst the Railway Clerks' Association is asking for a thirty-five-hour week.

An official statement issued subsequently by the Minister of Labour says that, in the light of all the circumstances, the Minister has decided to set up a court of inquiry under the Industrial Courts Act, 1919, to inquire into the applications and to make recommendations.

Swedish Labour Matters

On account of the shortage of labour which is being experienced in Sweden, an agreement has been made with Italy for the employment of 500 skilled Italian workers. It is reported that the Italians will be employed on the same conditions as Swedish workers and will be insured against unemployment, accidents and sickness. Of the 500 Italian workers, it is understood that 450 have already been apportioned between the Kockums Shipyard at Malmö, the Swedish Ball Bearing Company at Gothenburg, the A.S.E.A. Company, and the Storfors Ironworks. These companies are to place interpreters at the disposal of the Italians and it is intended also to arrange courses in Swedish for the foreign workers.

It may be added that this present importation of labour is understood to cover only a small part of Sweden's requirements. In the steel and engineering industries alone, it is calculated that there is a demand for 30,000 workers provided that raw materials and fuel can be supplied in sufficient quantities.

Another item of Swedish labour news relates to the annual report of the Swedish Federation of Trade Unions. It shows that at present there are 8787 trade unions in the country, with a total membership of 1,150,000. It also indicates that in Sweden generally industrial workers and civil servants have now reached the 1939 wage level.

French Engineering News

(From our French Correspondent)

PARIS, May 30, 1947.

The Société des Acieries de Longwy, which is embarking on a vast technical improvements programme within the framework of the Monnet Plan, has already set up a new Martin oven and is progressing with the modernisation of the Mont-Saint-Martin coking plant and the sheet metal rolling mill at Sedan. Technique at the Chiers Société has improved to such an extent that the company is taking out patents for certain of its steel processes which give very pure metal products. Large-scale standardisation and concentration is scheduled by the Monnet Plan for the company's Longwy plant. Almost all the 300,000 tons of metal passing through the plant annually will be turned into wire and strip by modern rolling mills. The Forges et Laminoirs d'Algérie at Oran has been working since the beginning of the year and for the first time since the end of the war a blast-furnace has been started at Halberger Hutte in the Saar.

* * *

France probably considered the coal question one of the most important problems to be settled at the Moscow Conference. Undoubtedly, given the necessary coal, France's recovery would be achieved in a minimum of time. Although France recognises the fact that the Allies are concerned with increasing Germany's production capacity in order to increase her capacity to pay reparations, the demand is that basic production of iron and steel should not be increased, but that Germany should concentrate on finished goods. The case put forward by France is that it is quite unnecessary for French ore to be sent to Germany so that Ruhr coal can be used in the manufacture of iron and steel which will then be delivered to German industrialists. It would be better for the German industry to work on the raw materials which could be supplied by French, Belgian and Luxemburg producers, whose blast-furnaces could deliver the necessary iron and steel provided they were supplied with coal, so that Germany could then produce the finished goods for distribution as reparations. Up to now, says France, all figures concerned with reparations have erred on the side of optimism.

* * *

The Agricultural Machinery Technical Centre is pursuing intensive tests in an attempt to improve performances. The tractor engine commission has just finished a series of tests on engines and is now studying air filters, while the handling methods commission has started an inquiry among users in order to study the handling of straw and dry fodder in bulk or trusses. A systematic study is also being made of harvester-thresher machines. A series of prototypes for stubble plough discs has been manufactured, and will be linked to the question of standardisation of discs for new French productions. With the standardisation service an inquiry is being made among disc constructors, which will facilitate rapid standardisation of all types of flat and convex discs used in agricultural machinery.

* * *

The big French programme of hydro-electric works now in course of construction in the Savoy is planned to provide between Tignes and Aiguebelle several hydro-electric plants. A dam at Tignes, nearly 500ft high and about 1000ft long, will hold up the waters of many streams in the High Tarentaise. The reservoir so formed will supply the central electric station at Brevières, which will produce about 160,000,000kWh annually. A tunnel more than 9 miles long will conduct the waters of the Isère to Malgevert, where it is estimated that the power generated will be about 480,000,000-kWh annually. Borings are taking place near Leopere-les-Bains with a view to driving a new tunnel some 10 miles in length, which, beginning at the lock gates of the Isère, will supply power for a plant which is expected to be constructed near Aiguebelle.

Notes and Memoranda

Rail and Road

BALTIC AND ADRIATIC RAIL CONNECTION.—A long-distance international train service was started early in May between Szezecin (Poland) and Basle, *vid* Poznan, Wroclaw, and Prague. In order to establish this rail connection between the Baltic and the Adriatic, extensive repair was necessary to a bridge over the River Oder, near Wroclaw. The work included the building—on a specially constructed scaffolding on a large river barge—of a complete span of the bridge, 60m long and weighing 250 tons.

L.M.S. EXPRESS ACCIDENT.—On Thursday, May 29th, when the 2.50 p.m. L.M.S. express train from Euston to Manchester was passing at high speed through a cutting near Denbeigh Hall, about a mile to the north of Bletchley, the six rearmost coaches became derailed. After breaking away from the train, and leaving the track, the coaches ploughed into the bank at the side of the cutting, which prevented the coaches from completely turning on to their sides. Notwithstanding the fact that the train was travelling at a very high speed and the impact of the coaches on the bank must have been very heavy, only thirty passengers complained of shock or cuts. Three passengers were taken to hospital with injuries but only one was detained. After the derailment and breaking away of the six coaches, the train with eight coaches travelled for nearly half a mile before pulling up. The wheels of two of these coaches are stated to have been off the rails for the whole of this distance, but the coaches remained upright and no one was hurt.

HIRE OF CONTRACTORS' PLANT.—New maximum rates of hire for road rollers, excavators and compressors and their associated equipment came into force on May 20th. The new rates are laid down in an Order, made by the Minister of Works, which also removes the control from rates of hire of all other items of plant covered by the old Order, excepting concrete mixers, mobile road cranes, crane grabs and skips, dumpers, dragline buckets, high-lift shovels, mechanical trenchers, piling plant, tractors and tractor equipments, and elevating graders without tractors. The new Order is the first result of a general review of the statutory maximum rates of hire of plant. It was decided to revise the rates for road rollers, excavators of up to 1½ cubic yards capacity, and compressors because these items are in greatest demand and the rates of hire as laid down in the old Order were least in keeping with present-day conditions. The new rates are contained in the schedule to the new Order (S.R. & O., No. 915, 1947). For purposes of easy reference, the schedule also lists the rates of hire of plant which remain unchanged.

Air and Water

AIRPORT FOR ADELAIDE, AUSTRALIA.—It is reported that a new airport, covering an area of approximately 1786 acres, is in course of construction at West Torrens, Adelaide, Australia. It will be classified as a medium-range regular airport, and is to have three runways, one 6500ft long and the other two each 5000ft to 5500ft long. Ultimately, the new airport will be able to deal with 500 aircraft movements a day.

THE LOCKHEED AIRCRAFT SERVICE.—An international organisation for the maintenance and overhaul of multi-engined aircraft of all types has recently been established by the Lockheed Aircraft Corporation. It is to be known as the Lockheed Aircraft Service, and has already made arrangements to service aircraft for French, Dutch, Irish, Venezuelan and Argentine air lines in addition to those of several American air lines and corporations. A maintenance base has been established at Shannon airport in Eire, and field offices in Paris, Amsterdam and Caracas.

SWEDEN'S HYDRO-ELECTRIC PLANTS.—In order to meet the increasing demand for electric power, an extensive programme of hydro-electric works construction is being carried out in Sweden. The biggest of the new plants being built is the Harspranget station of 255,000kW, situated on the Lule River above the Arctic Circle. The station is expected to be ready for operation in 1951, and will be connected with the consuming areas in central and south Sweden by a transmission line of approximately 600 miles. The Krangede and Gammetange stations on the Indal River in north Sweden are being enlarged, and two new stations are being constructed in the same area.

Miscellanea

AN ANGLO-BELGIAN EXHIBITION.—An exhibition is to be held in the Salle de la Madeleine, Rue Duquesnoy, Brussels, from September 4th to 9th inclusive, to show the products of British manufacturers to buyers for the European markets. It is being organised by H. & H. Trading (London), Ltd., 5, Copthall Buildings, Copthall Avenue, London, E.C.2.

THE LATE CAPTAIN E. A. BOLTON.—We have noted with regret the death, on May 19th, of Captain E. A. Bolton, M.I. Mech. E., chairman and joint managing director of Bolton's Superheater and Pipe Works, Ltd., of Stockport. Captain Bolton was well known in northern engineering circles, and was the only son of the late Andrew Bolton, who was a pioneer in the development of steam superheating.

EXPORT LICENSING CONTROLS.—A new Board of Trade Order which comes into force on June 9th makes certain changes in export licensing control. From that date export licences will not be required for sulphur, mica, well-drilling machinery and certain chemicals. Additions to the schedule of goods requiring export licences include cast iron ingot moulds, electro-cardiographs, and lead-acid accumulators of all types.

AMERICAN STEEL PRODUCTION.—Statistics compiled by the American Iron and Steel Institute show that in the past twelve months steel production in the U.S.A. has totalled over 72,000,000 metric tons. For the current calendar year a total output of about 76,000,000 tons is anticipated. The operating rate of the American steel industry during the last five months is said to have been at approximately 95 per cent of ingot capacity.

TECHNICAL MISSION TO THE RUHR COALFIELD.—"The Technique of Mining in the Ruhr," by Dr. C. H. Fritzche, which has just been published by H.M. Stationery Office, price 9d., is Appendix V to the "Technical Report on the Ruhr Coalfield," prepared by a Mission from the Mechanisation Advisory Committee of the Ministry of Fuel and Power. This Mission visited the Ruhr coalfield in the autumn of 1945 to examine new developments in coal-mining technique. Vol. I of the Mission's report was published by H.M. Stationery Office in June, 1946, and Vol. II, containing nearly 200 illustrations of plans of mines and diagrams and photographs of German mining equipment and lay-outs, was published in two parts in December, 1946. It was intended that the appendices to the report and the reports by the investigating teams which were organised on the basis of the Mission's recommendations should be published together in Vol. III, but this has not proved practicable, and these appendices and reports are therefore being published separately. The appendices consist mainly of translations of German technical documents, which will be of interest to British mining engineers and technicians. The appendices and the reports of the investigating teams will be published as and when they are ready.

INSTITUTION OF METALLURGISTS.—Examinations for the licentiateship and associateship of the Institution of Metallurgists will be held during the week beginning September 7, 1947, in London and other centres to be decided upon when the number of candidates in different areas is known. Application for permission to enter for the examination should be made not later than June 14th on forms to be obtained, with copies of the regulations, from the Registrar, the Institution of Metallurgists, 4, Grosvenor Gardens, London, S.W.1. Full details of the arrangements for the examinations and instructions as to payment of fees, will be sent to those whose applications are accepted, before the end of June for completion and return with the appropriate fee. Each candidate for the Institution's examination for the licentiateship must produce evidence of good general education; knowledge of chemistry, physics and mathematics to approximately university intermediate science examination standard; and not less than two years' experience in metallurgical science or practice. Each candidate for the Institution's examination for the associateship must produce evidence of general education to approximately matriculation standard; knowledge of chemistry, physics and mathematics to approximately university intermediate science examination standard; and three years' experience in metallurgical science or practice. Examinations for the fellowship may be arranged at about the same date, and intending candidates should apply for permission to enter for the examination, stating the branch of metallurgy in which they wish to be examined.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Institute of British Foundrymen

Tuesday to Friday, June 17th to 20th.—Annual Conference in Nottingham.

Institute of Economic Engineering

Sunday, June 8th.—Waldorf Hotel, W.C.2. "Factors Affecting Output per Man-Hour," E. H. Lewis. 2.30 p.m.

Friday, June 13th.—Cowdray Hall, W.1. "Research and Expansion in Industry," R. Cecil Smart. 7 p.m.

Institute of Physics

Friday and Saturday, July 18th and 19th.—INDUSTRIAL RADIOLOGY GROUP: Electric Lamp Manufacturers' Association, 2, Savoy Hill, W.C.2. A Symposium on "Methods of Crack Detection."

Institute of Welding

Tuesday to Friday, June 3rd to 6th.—North-East Coast meeting, Newcastle-on-Tyne.

Wednesday, June 25th.—Grosvenor House, Park Lane, W.1. Annual dinner. 7.15 p.m.

Institution of Civil Engineers

Tuesday, June 10th.—Great George Street, S.W.1. Annual general meeting. 5.30 p.m.

Institution of Electrical Engineers

Saturday, June 21st.—S. MIDLAND CENTRE.—Visit to Meaford power station. 12.30 p.m.

Institution of Mechanical Engineers

Sunday to Friday, June 8th to 13th.—Centenary celebrations in London (see page 399), May 9th.

Institution of Mining Engineers

Wednesday to Friday, June 18th to 20th.—Summer meeting in Edinburgh.

Institution of the Rubber Industry

To-day, June 6th.—Connaught Rooms, Great Queen Street, W.C.2. "The Impact of Synthesis on the Rubber Industry," Dr. Philip Schidrowitz. 5.30 p.m.

Iron and Steel Institute

Wednesday, June 11th.—IRON AND STEEL ENGINEERS' GROUP: 4, Grosvenor Gardens, S.W.1. Discussion on "Steam Generation and Utilisation in Iron and Steelworks." 10.30 a.m.

Wednesday and Thursday, June 18th and 19th.—Inst. of Civil Engineers, Great George Street, S.W.1. Symposium on Powder Metallurgy. 2.15 p.m. Wednesday and 10 a.m. Thursday.

Thursday, June 26th.—4, Grosvenor Gardens, S.W.1. "The Effect of Different Methods of Pretreating Iron and Steel before Painting." F. Fancutt; and "The Protection of Iron and Steel by Metallic Coatings," J. C. Hudson and T. A. Banfield. 2.30 p.m.

Public Works Congress and Exhibition

Monday, July 21st, to Saturday, July 26th.—London, Olympia.

Stephenson Locomotive Society

Saturday, June 28th.—Visits to Brighton works, Redhill and Brighton running sheds, Southern Railway.

Friday, July 4th.—Visit to Swindon Works, G.W.R.

Women's Engineering Society

Saturday, June 14th.—Visit to the City and Guilds College, Exhibition Road, S.W.7. 2.30 p.m.

Catalogues

SPANNER BOILERS, Ltd., 10, Hopton Road, S.W.16.—Brochure No. 12, describing the "Spiralflo" thimble-tube boiler and the "Steddyflo" water-tube boiler.

SIEMENS ELECTRIC LAMPS AND SUPPLIES, Ltd., 38, Upper Thames Street, E.C.4.—Catalogue No. Z.146, dealing with house service cut-outs and power fuse boxes.

SOUTH BEND LATHE WORKS, 225, E. Madison Street, South Bend, 22, Indiana, U.S.A.—Catalogue describing the 13in swing quick-change gear and tool room lathes.

CHATWOOD SAFE AND ENGINEERING COMPANY, Ltd., Shrewsbury.—Illustrated brochure giving technical data of an automatic hob and helical spline grinding machine.

E. H. JONES, Ltd., Edgware Road, The Hyde, N.W.9.—Folder on the model 2 C.V.A. gear hobbing machine, and leaflet dealing with the No. 927 self-centring shaft vice.

GEORGE KENT, Ltd., Luton.—Publication No. 845/846, describing Kent "Multelec pH Recorders and Controllers," and catalogue on "M" mechanical water meters.

INDESTRUCTIBLE PAINT COMPANY, Ltd., 6, Chesterfield Gardens, Curzon Street, W.1.—Catalogue describing "Voltalac" insulating varnishes and compounds (price 10s. 6d.).

BEYER, PEACOCK AND CO., Ltd., Abbey House, Westminster, S.W.1.—Illustrated catalogue containing examples of various steam locomotives for different duties and gauges.

RAYBESTOS-BELACO, Ltd., Everite House, Southwark Street, S.E.1.—Data book, eleventh edition, size and price guide of brake and clutch linings used on cars and commercial vehicles.

Personal and Business

MR. L. T. DAWES has been appointed a director of Beyer, Peacock and Co., Ltd.

MR. F. S. SNOW, M. Inst. C.E., has been elected President of the Institution of Structural Engineers.

MR. J. H. PROUD and Mr. R. B. Weallans have been appointed directors of the Burntisland Shipbuilding Company, Ltd.

MR. BASIL SANDERSON has been re-elected chairman and Mr. E. H. Watts vice-chairman of the Shipping Federation, Ltd.

E.C.S., Ltd., has appointed Manufacturing Services, Ltd., Cheltenham, as sole export agents for "Armachrome" gauges.

MR. W. GLASS, A.M.I. Mech. E., director and general manager, has been appointed joint managing director of Johnson and Phillips, Ltd.

DAVID BROWN TRACTORS, Ltd., has acquired the wartime light shell factory at Stanningley, Leeds, for the manufacture of light implements.

W. J. FRASER AND CO., Ltd., has been allotted a factory at Monk Bretton, near Barnsley, Yorks, for the manufacture of chemical and allied plant.

LORD ASHFIELD has been reappointed chairman of the London Passenger Transport Board. Mr. Geoffrey Heyworth has been reappointed a part-time member of the Board.

MR. G. C. TROWBRIDGE has been appointed managing director of A. C. Wickman, Ltd., in succession to Mr. A. C. Wickman. Mr. Wickman continues to serve as chairman of the company.

MR. W. NITHSDALE, M.I. Mech. E., M.I.N.A., has retired from the position of resident director of Richardsons, Westgarth and Co., Ltd., West Hartlepool. Mr. W. E. Loveridge has been appointed to succeed him.

THE BRISTOL AEROPLANE COMPANY (HOUSING), Ltd., states that it is now collaborating with Structural and Mechanical Development Engineers, Ltd., Slough, in the design and manufacture of light alloy structural components and buildings.

MR. G. C. LERCHE, Mansion House Chambers, Close, Newcastle-upon-Tyne, has been appointed sole British agent for the products of Oerlikon Machine Tool Works, with the exception of the rigid radial drilling machine and the profile form grinding machine.

Reports on German and Japanese Industry

Limited numbers of copies of the reports of Intelligence Objectives Sub-Committees on German and Japanese Industry listed below can be obtained from H.M. Stationery Office at the prices stated.

No. of report.	Title.	Post free. s.	d.
B.I.O.S.:			
1038	Ruhrchemie A.G., Sterkrade-Holten, near Oberhausen, Ruhr: Methanisation of Coal Gas and Production of Acetylene from Methane	1	7
1044	German Carbide and Cyanamide Industry: Carbide Production	7	2
1045	German Carbide and Cyanamide Industry: Handling of Carbide in Bulk	1	1
1051	German Acetylene Chemical Industry: The Concentration of Dilute Acetic Acid	2	1
1054	German Acetylene Chemical Industry: Ethyl-Aceto-Acetate...	2	7
1055	German Acetylene Chemical Industry: Corrosion Resistant Linings	3	8
F.I.A.T.:			
913	Synthetic Detergent Applications	1	1
919	The Manufacture of the Diethanolamine Salt of P-Methyltolyl Carbinol-Camphoric, Acid Ester, and a Brief Evaluation of its Pharmacologic Properties...	1	1
935	The Production of Higher Vinyl Esters: Ludwigshafen	1	1
941	The Quantum Yield in the Isomerisation of Crocetindimethylester by Light	0	7
950	Xylene-Formaldehyde Condensation Products	0	7
965	Manufacture of "Pressal" Adhesive	0	7

EVALUATION REPORTS Price 2d. (post free 3d.)—

C.I.O.S.:			
E/R 332 ...	Report on Aircraft Windshield De-Icer (Electric)		
E/R 339 ...	Report on Alfred Becker Co., Hemer (Iserlohn): 16 Barrel 81mm Mortar-Reihenwerfer RG 16		
E/R 6	I. Bruning und Sohn (Ibus): Plywood		
E/R 21 ...	Klockner Werke A.G. Rolling Mills: Metallurgical		
E/R 168 ...	Max Specht: Coffee Stabilisation Process		
E/R 185 ...	Vereinigte Glanzstoff Fabrik A.G.: Rayon Yarn Production		
E/R 189 ...	J.P. Bemberg Oehderstrasse: Production of Filament Rayon		
E/R 272 ...	(*a*) Deutsche Gasrusswerke G.m. b.H., (*b*) Degussa Kalacheuren: Carbon Black for Rubber		
E/R 370 ...	Degussa Hiagwerke A.G.: Wood Carbonisation and Tests for Activated Carbon		
Classified List No. 2	Consolidated List under Subject Headings of all Industrialists' Reports on Germany published up to and including October 26, 1946	0	8
Technical Index	Alphabetical Subject Index of Reports published up to and including July 27, 1946	5	3
810	German Wool Textile and Mantle Plush Manufacture	6	2
847	German Chlorine Plants in the American, French and British Zones: Part II, Liquid Chlorine, including Distribution of Gaseous Chlorine	2	8
848	German Chlorine Plants in the American, French and British Zones: Part III, Synthetic Hydrochloric Acid	3	8
849	German Chlorine Plants in the American, French and British Zones: Part IV, Sodium Hypochlorite	1	7
850	German Chlorine Plants in the American, French and British Zones: Part V, Evaporation and Finishing of Diaphragm Cell Caustic Soda Liquor... ...	2	8
915	German Manufacture of Agricultural Machine Parts	2	8
981	Light Alloys: Notes on German Technique on Continuous Casting and Extrusion of Aluminium Alloys, with Particular Reference to Tube Extrusion; Tube Reducing Machines and Vertical Extrusion Presses	2	1
986	I.G. Farbenindustrie A.G.: Manufacture of Intermediates for Dyestuffs at Griesheim, Hoechst, Ludwigshafen, Mainkur, and Offenbach—in two parts		
	Part I	25	0
	Part II	17	4
B.I.O.S.:			
1007	Instrumentation and Control in the German Chemical Industry	16	4
1069	Two-Circle Goniometers and Polarising Film (Germany) ...	2	8
1123	German Methods of Control and Manufacture of Hollow-Clay Blocks and Roofing Tiles	2	1
F.I.A.T.:			
353	Cargo Ship Cranes, as Built by Demag...	1	7
575	Developments in Diesel Engineering	5	8
795	Lanthanum, Neodymium, Praseodymium and Uranium Compounds Prepared by Auergesellschaft, Berlin	0	7
882	Anodes: Composition and Use of Anodes for Electroplating ...	3	2
886	Manufacture of Melamine	1	1
888	Methanol Synthesis at I.G. Farbenindustrie Plant at Oppau ...	2	1
890	Supplement to J.I.O.A. Report No. 56, "Selenium Rectifier Development in Germany" ...	2	8
905	Determination of Suitability of Paraffin Mixtures for Conversion to Fatty Acids by Catalytic Oxidation	0	7
911	Styroflex Dielectric Capacitors ...	0	7
B.I.O.S.:			
1040	Manufacture of Woodworking Machine Tools in the American and French Zones of Germany...	1	1
1063	Polishing of Copper and Zinc Sheets for the Photo-Engraving and Photogravure Industry ...	1	1
1068	The German Portable Power Tool Industry: Engineers' Tools (Metal and Woodworking) ...	11	9
1082	Manufacture of Electrical Steel Sheets in Germany, with Particular Reference to Transformer Sheets	9	3
1087	The Manufacture of Chemical Stoneware in Germany	4	2
1088	Textile Printing in Germany ...	4	2
1090	Cellulose Acetate Manufacture: Interrogation of Drs. Rohm, Schnegg and Ziegler (I.G. Farbenindustrie, Dormagen)	1	1

B.I.O.S. Information Section, 37, Bryanston Square, W.1, which has at its disposal a considerable volume of information not in a form suitable for general reproduction, is prepared to receive enquiries regarding all problems relating to scientific and technical intelligence on both German and Japanese industry.

A Seven-Day Journal

Industry and Research: F.B.I. Sheffield Regional Conference

On Thursday, June 5th, there was a large attendance at the F.B.I. regional conference on industrial research, which took place at the Royal Victoria Hotel, Sheffield. The chair was taken by Sir Walter Benton Jones, of United Steel Companies, Ltd., and the first paper was read by Sir William Larke, Chairman of the F.B.I. Research Committee, who took as his subject "Research and National Recovery." He pointed out that shortage of materials could be mitigated by increased efficiency in their use, and the output per unit of labour was not incapable of improvement. Our present economic position necessitated, he said, the close examination of our industrial practice, which should place us in a stronger competitive position and lead to the ultimate realisation of our aspirations for a higher standard of life. In a second paper Dr. C. P. Jones, of Sheffield University, traced the historic growth and economic development of Sheffield industries. In a third paper Professor R. J. Sarjant, D.Sc., of Sheffield University, dealt with industrial problems of the Sheffield area, and indicated some ways in which they might be solved by research methods. At the afternoon meeting Lord Dudley Gordon, the Chairman of Hadfields, Ltd., presided, and spoke of the need for more research workers. He referred to the strain which had partly caused the too early deaths of Mr. Dickenson of the English Steel Corporation, Dr. Hatfield of Firth-Brown, Dr. Swinden of United Steels, and the recent retirement of Mr. Dawson, research director at Hadfields. The situation might be eased, he said, if the Service Departments would consent to the release of many scientific workers engaged in armament production, whose service could with advantage be utilised on research work. In the first afternoon paper Dr. W. J. Rees described the Sheffield research organisations, their facilities and their activities; and in a second paper Dr. F. L. Lea, of Edgar Allen and Co., Ltd., dealt with the smaller firm and its application of research. The papers were followed by a discussion. Sir Charles Goodeve, of the British Iron and Steel Research Association, summed up the findings of the conference, which is the third of its kind to be held.

British Scientific Instruments Exhibition

An exhibition of British scientific instruments organised by the Ministry of Supply, with the co-operation of the Scientific Instruments Manufacturers' Association, was opened by the Minister, Mr. John Wilmot, at Charing Cross Underground Station on June 10th. It will remain open to the public until Thursday, July 3rd. Designed to illustrate the important part played by scientific instruments in increasing production and raising the standard of living, the exhibition is centred upon the homely examples of a lady's bicycle and a shopping basket. From these commonplace objects interest is drawn to a range of instruments, each of which is typical of the precision apparatus required for manufacturing the bicycle and for processing the simple items of food contained in the shopping basket. To give a complete picture of the products and activities of British scientific instrument makers is beyond the scope of this exhibition, the purpose of which is rather to indicate in miniature the wide range of an industry whose peacetime products are used in engineering, medicine, surgery and in numerous industrial processes and laboratories. Amongst the instruments displayed are two forms of comparator, a meter for measuring plating thickness, and a supersonic flaw detector arranged as a working exhibit. Instruments, such as those used, for example, in food processing, include a self-contained moisture meter, a pH meter and a critical angle refractometer. An exhibit of some general interest is a graph showing the rapid and sustained growth of the industry, which was already firmly established in the export market before the recent war and has made spectacular strides within the past eight years. The export of medical and surgical instruments, for instance, has increased nearly six-fold since 1938; a ten-fold increase has been recorded in certain categories of scientific glassware; while the export of scientific instruments generally has nearly trebled in the same period.

Organisation of Industrial Research

On Monday evening, June 9th, Mr. Robert Price Russell, the president of the Standard Oil Development Company, U.S.A., gave a lecture on "The Organisation of Industrial Research" in the Council Room of the F.B.I., 21, Tothill Street, S.W.1. Sir Frank Smith took the chair. This was the first of a series of lectures to be held in London under the auspices of the F.B.I. Industrial Research Committee. Mr. Russell was presented with the Cadman Memorial Medal by the Institute of Petroleum on June 4th for his contributions to the advancement of petroleum research. In his own company, Mr. Russell said, there had been an hundredfold expansion of research staff during the last twenty-seven years, and an analysis of costs and income showed that for each £1000 spent by the research and development group, a total of £15,400 of added profit had resulted to the stockholders. Two conditions essential to successful industrial development were a healthy economic climate and a sound political climate. Other vital links in the chain of successful industrial organisation were natural and human resources, invention and research, development, engineering application, production management, labour, effective distribution, and competent executive management. Each was essential if a nation was to benefit from technical advances. Future progress in both our nations would, Mr. Russell went on to say, be determined by whether these factors, which formed the links in the industrial chain, were strengthened or weakened. Technical staffs were to-day seriously depleted, but a way must be found not only to meet our own pressing problems, but to take care of at least some of the requirements of those countries friendly to our two nations. These matters would not bear long delay. In order to help in building a world of peace, we must not only guard against the deterioration of the high standards of technical achievements set during the war, but we must advance the effectiveness of our research development and engineering, even beyond the present level. Given a free and truly competitive system in which to work, our scientific groups would undoubtedly be able to deal successfully with the many problems which the future would unquestionably bring.

Royal Mail Lines, Ltd., Liners and Cargo Ships

In the statement made by Mr. Walter C. Warwick, the chairman of Royal Mail Lines, Ltd., at the fifteenth ordinary meeting of the company, held in London last week, reference is made to the increasing release of ships for the company's passenger and cargo-carrying services. Some "Highland" type ships are now in service and others are due for release. The liner "Andes" is being reconditioned at Harland and Wolff's Belfast yard and the "Alcantara" will be reconditioned in London during the autumn. Mr. Warwick commented on the slow pace of the work of restoring the customary first-class amenities on these fine ships. Delay, he said, was inevitable with the very serious shortage of materials and labour. New motor vessels received during the year had included the "Brittany" and the "Araby" and the steamer "Loch Garth," designed and built by Harland and Wolff, Ltd., for the company's North Pacific service. A sister ship, the "Loch Avon," is expected to be delivered in August. With the acquisition of four American "Liberty" ships, which have been on charter to the British Government and have been operating under the company's management, and with the new ships delivered or about to be completed, the deadweight tonnage of Royal Mail ships will be substantially equal to the pre-war tonnage of the company. The speed of the new cargo liners is considerably higher, and the potential carrying capacity larger than before the war, but unfortunately that advantage is almost entirely nullified by the great delays experienced at the present time in the turn-round of ships in ports both at home and abroad. Port expenses have increased, and all kinds of stores have risen in price. The company has decided to convert two of its three remaining coal-fired ships to oil burning. The two ships in question are the "Teviot" and the "Tweed," purchased from the Government last year. It seems inadvisable to convert the remaining ship on account of her age.

The Reconditioned P. & O. Liner "Stratheden"

It is announced by the Peninsular and Oriental Steam Navigation Company that the 27,700-ton liner "Stratheden," which was returned to Vickers-Armstrongs' Barrow-in-Furness shipyard in July, 1946, for reconversion, will sail for Australia on Friday, June 27th, under the command of Captain S. W. S. Dickson, who has commanded the ship since 1944. The reconditioning of the liner at Barrow has enabled a thorough overhaul of her propelling and auxiliary machinery to be made. It is gratifying to learn that during the trying and prolonged period of the war years, during which she steamed 468,094 miles, her Vickers-Armstrong geared turbine machinery and Babcock and Wilcox boilers did not give one moment's anxiety. The "Stratheden" never missed a sailing date nor a convoy, and indeed at the northern convoy ports she established something of a reputation for reliability. Whilst the work of reconverting the passenger accommodation was proceeding, the boilers, geared turbines and auxiliary machinery were opened up for examination. Apart from replacements due to normal wear and tear, no major repairs were undertaken, and no alterations were found to be necessary.

The Finance Bill, 1947

The Federation of British Industries and the Association of British Chambers of Commerce have recently submitted to the Chancellor of the Exchequer a Joint Memorandum dealing with the Finance Bill. The memorandum comments on the undesirability of the duty on Bonus Issues; the inequity of a special tax on business such as the Profits Tax, and on the hardships likely to be inflicted by the Retirement Benefit provisions. On the first point, the memorandum says that a straight issue of bonus shares by a company consists only in the handing to its shareholders of further share certificates, representing the reserved profits of the company. The company is not one penny the richer, the effect being to lock up in the business reserves which might otherwise have been distributed. The memorandum asserts that it is most objectionable to subject to a duty the mere act of crystallising the reserves as capital, and urges that the practice is one that should be encouraged and not taxed. With regard to retirement benefits, the memorandum expresses support of the clauses which are designed to prevent tax evasion, but says that some clauses appear to go far beyond that. Pensions and similar benefits, the memorandum adds, are of great importance to industry and are as much a part of its costs as wages and salaries. If it is considered that the present taxation treatment of retirement benefits is unsatisfactory, as indeed it is, a careful enquiry should be made into the whole field of deferred remuneration.

Progress in Petroleum Research*

By ROBERT PRICE RUSSELL†

No. II—(*Continued from page 492, June 6th*)

Hydrocarbon Synthesis

THE second important process I would like to consider with you is that of hydrocarbon synthesis. Here the fluid catalyst technique is directed to the conversion of natural gas and coal into liquid fuels.

Synthetic hydrocarbons may be produced either from gas or coal. These basic raw materials, however, must first be converted into synthesis gas (a mixture of carbon monoxide and hydrogen). Once the synthesis gas has been formed and purified, the remainder of the process is similar for both coal and natural gas. The synthesis gas is fed from a generator into a reactor and converted in the presence of a fluidised catalyst into synthesis products, such as petrol, diesel oil and chemicals.

At the present time in the United States synthesis from natural gas is closer to plant-scale application than synthesis from coal. A representative technique for the production of synthetic hydrocarbons from natural gas is illustrated in Fig. 4, where the various steps in this process are shown, from the time the gas enters the generator until the liquid products are ready for final refining.

After preheating in a heat exchanger to a temperature of about 930 deg. Fah., the natural gas, principally methane (CH_4), is fed into a synthesis gas generator, together with similarly preheated, compressed oxygen. The burning zone of the generator is an open chamber lined with refractory insulation, and here the methane is converted by partial oxidation to carbon monoxide and hydrogen. The temperature level in the combustion zone is about 2450 deg. Fah. and the pressure 20 to 30 atmospheres.

On leaving the combustion zone the hot products of combustion are cooled, first in a waste heat boiler in the generator and then by heat exchange with incoming methane and oxygen. The gas now enters at the base of a fluid type reactor operating at about 660 deg. Fah. and a pressure of 20 to 30 atmospheres. Here, in the presence of an iron catalyst which, in "fluid" state, is in constant and violent motion, it reacts to form synthetic hydrocarbons and water. The reaction liberates a very large amount of heat, amounting to 14,500,000 B.Th.U. per ton of liquid produced. But high rates of heat transfer through cooling tubes immersed in the fluidised catalyst permit the maintenance of uniform temperature throughout the catalyst. The heat of the reaction is absorbed in the vaporisation of water to form high-pressure steam, which is a source of heat and power throughout the plant.

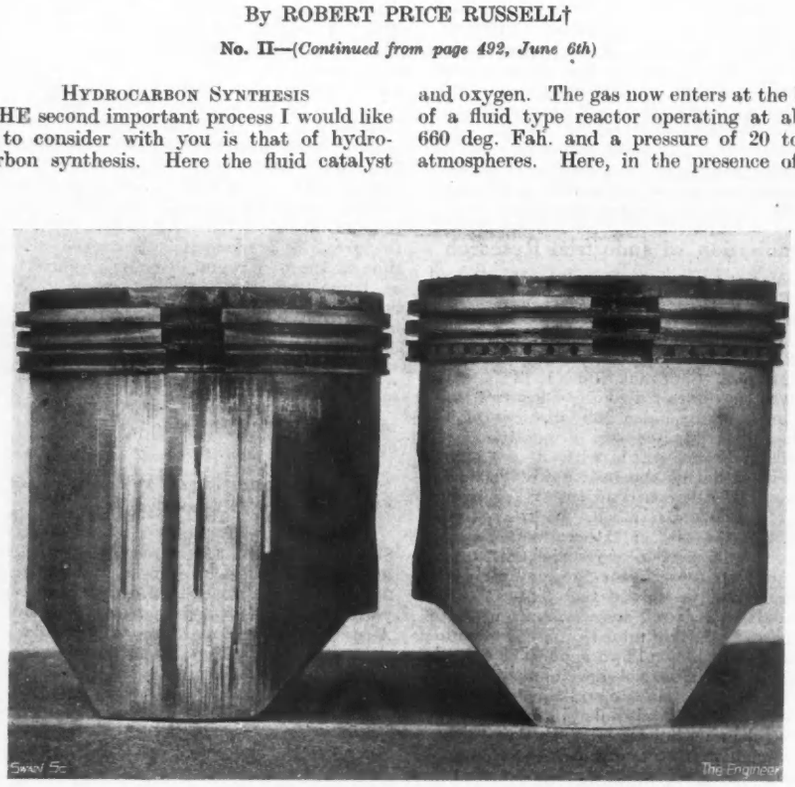


FIG. 5—OIL OXIDATION RESISTANCE TESTS

In the past, the major difficulty in applying the synthesis operation to large-scale production has been the maintenance of an even catalyst temperature, despite this large heat evolution, for a relatively deep bed of catalyst is employed in the synthesis reactor. However, this difficulty has been solved as efficiently as in the case of the fluid catalytic cracking process.

The synthesis product leaving the fluid bed in vapour form carries with it a small amount of entrained catalyst. This is recovered in a cyclone and returned through a dip-pipe to the catalyst bed. The vapours leave the reactor to be cooled in a condenser and pass from there into a separator where the liquids are separated from the gases, some of which are recycled for further processing. The liquid products—high octane petrol, diesel oils and chemicals — then undergo normal finishing treatment.

The gaseous portion of the product is stripped of light hydrocarbon content and the residual tail gas is used to help provide power and heat requirements of the process. Or part of it may be sold as fuel.

In the hydrocarbon synthesis process developed in Germany, using pelleted or granular catalyst in fixed beds, large numbers of closely spaced cooling tubes were required and the capacity of the reactors was limited by the ability to remove heat. In the fluid type reactor developed in the United States, heat transfer rates are so much higher than was possible with the German tubular type that less than 1 per cent as much cooling surface is required. This naturally means a large reduction in investment, maintenance and operating cost. Not only are the new iron catalysts used in the fluid process cheap in initial cost, but they also result in production of high-octane petrol instead of the exceedingly poor knock-rating product made by the Germans with their more expensive cobalt type catalysts.

Costs: A Comparison

According to our most recent estimates, a hydrocarbon synthesis plant erected in the United States to produce 420,000 tons per year of hydrocarbon liquid products from natural gas will cost about £7,600,000, or

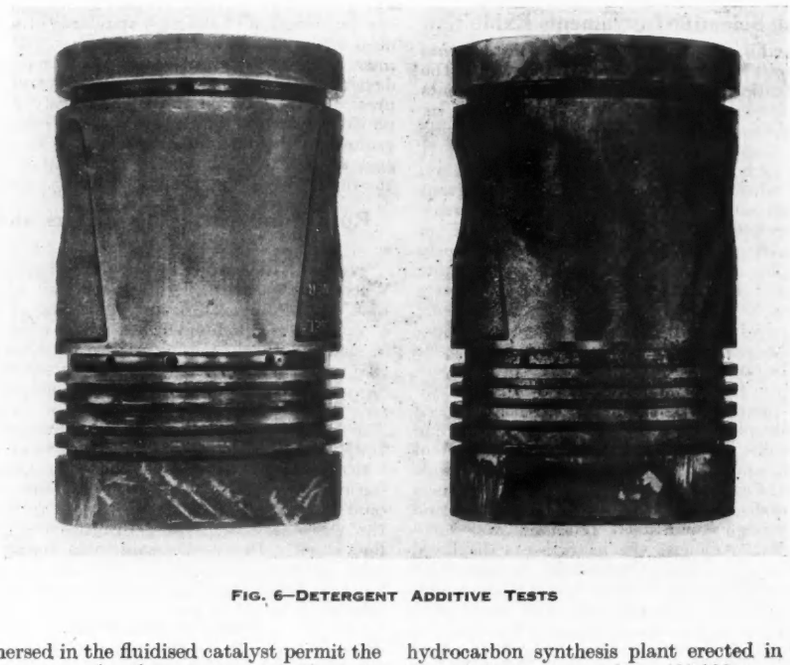


FIG. 6—DETERGENT ADDITIVE TESTS

* Second Cadman Memorial Lecture. The Royal Institution, June 4, 1947. Abstract.

† President, Standard Oil Development Company.

roughly £18 per yearly ton. This is over twice the cost of a complete refinery capable of producing the same products from crude oil. Of the 420,000 tons per year of hydrocarbon synthesis liquid products, approximately 380,000 tons per year will be petrol and 40,000 tons per year gas oil. The petrol has an A.S.T.M. octane number, unleaded, of 80 and a research octane number on the same basis of 93. In addition, a considerable quantity of oxygenated water-soluble products is produced, consisting largely of alcohols. Assuming that the oxygenated products have the same value as petrol and that natural gas is charged for at 3d. per 100 cubic feet, the cost for petrol works out at 3·9d. per Imperial gallon. The estimated cost of producing the same quality petrol in the United States from certain typical crudes is about 5·7d. per Imperial gallon.

Largely because of the additional plant facilities required, the production cost of synthetic petrol from coal is to-day slightly higher than the cost of petrol from crude oil. For example, a United States plant capable of producing some 380,000 tons a year of petrol from coal, together with about 42,000 tons per year of diesel fuel or gas oil, and a considerable quantity of oxygenated water-soluble products (mainly alcohols), is estimated to cost about £15,000,000. In addition to the high octane motor petrol and diesel fuel products, this plant would also yield nearly 40 million cubic feet a day of high heating value gas. Taking into account areas where this gas could be sold for about 1s. 8d. per 1000 cubic feet, and allowing suitable credit for the diesel oil and chemicals produced, the cost of petrol from such a plant—with good grade coal at 10s. per ton, a figure which can be realised in some parts of the United States—comes to approximately 6·5d. per Imperial gallon.

If no market existed for the by-product fuel gas, the cost of petrol would be about 7·2d. per Imperial gallon. The figure of 6·5d. is not much more than the cost of producing similiar quality petrol from crude oil at present United States crude prices.

The plant investment, however, is more than four times greater, and although the figure of 6·5d. per gallon includes normal depreciation, it does not allow for any return on the added investment. Nevertheless, even with a fair return on the greater investment, motorists could operate their cars on synthetic petrol from coal at an average additional cost of not more than 6d. a day.

From the investment and operating costs just cited, it is clear that the synthesis operation, based on natural gas, even after all the recent major advances, finds true economic justification in only a few parts of the world. Large-scale application to coal requires additional study, but vigorous investigation is now in progress which will doubtless lead to further significant improvements. The present status is such, however, as to warrant the close interest of anyone interested in the oil industry.

Other Applications of the Fluid Technique

Major new developments of a broad and fundamental nature occur only infrequently. During the twenty years I have been working in the oil industry, for example, less than a dozen such broad advances have appeared. The fluid catalyst principle is without doubt a fundamental advance. It represents something more than a major contribution in the field of catalytic cracking and hydrocarbon synthesis, for it also provides a new chemical engineering medium which appears destined to have numerous important applications in the oil, chemical and other process industries. Among these, it can be used in making phthalic anhydride for resin manufacture, in lime-burning and coal gasification. In the iron-smelting industry it offers such significant possibilities of lowering costs and reducing metallurgical coke requirements per ton of pig iron produced—perhaps even eliminating the need for metallurgical coke—that the technique is now receiving vigorous study in several quarters.

Lubrication Improvements

In the field of lubricants the processes of catalytic cracking and hydrocarbon synthesis have also opened up new possibilities for improvements far beyond what was deemed possible a few years ago. The special characteristics essential for satisfactory lubricating oils can be imparted only—or more readily—through the use of additives. Catalytic cracking has uncovered new olefin sources and hydrocarbon synthesis has added still other olefins to our existing raw materials for manufacturing additives.

British scientists have done impressive work in the development of lubricants—on film strength agents in the early 'twenties and on metallic soaps as sludge dispersers in the early 'thirties. They were also responsible for the first large-scale use of such detergent additives in aviation oils during the war.

Modern high-speed automobile and aviation engines really give lubricating oil a terrible beating, and it therefore becomes necessary to improve on Nature's product. Small amounts of specially synthesized chemical compounds are added to improve the high temperature stability of the oil, reduced sludge formation and ring sticking, and minimise bearing corrosion.

Fig. 5 shows two pistons from Chevrolet engine tests run under standard conditions and with high oil temperature. One of the oils used was lacking in oxidation resistance, while the other had a small amount of inhibitor added to it and presented good oxidation resistance. The difference in the condition of the two pistons is readily apparent.

The results of tests on a Hercules diesel engine, run for 120 hours under standard conditions, are shown in Fig. 6. The oil used in one test was lacking in detergent properties and unable to keep any sludge in suspension, with the result that there was varnish formation of a serious type. The oil used in the other test contained a small amount of special detergent additive which kept the pistons in exceptionally clean condition.

Much heavy duty commercial equipment to-day is experiencing trouble-free performance principally because the proper type of detergent additive is incorporated in the lubricating oils used. During the war, heavy-duty oils were called upon to work under the most drastic conditions of military service, and one can well imagine what might have happened had these oil additives not been available. The lubricating oil additives used to-day, remarkable as they are, unquestionably will be supplanted by still newer materials uncovered in the course of the intensive research now in progress.

An Engineer looks at Bolivia

By ROLT HAMMOND, A.C.G.I., ASSOC. M. Inst. C.E.

No. I

BOLIVIA derives its name from "Republica de Bolivar," after Simon Bolivar, that famous and romantic character known throughout Latin America as El Libertador (the Liberator). Much has been written about the long struggle in which he engaged for some fifteen years to throw off the yoke of Spain from the nothern part of the continent; he died in semi-poverty, like many of the world's great men.

Early History of Bolivia

At the period of the Spanish colonial empire, the territory now known as Bolivia was an integral part of the vice-royalty of Peru and Buenos Aires; such extremely cumbersome administrative division, with resident viceroys at Lima and Buenos Aires was hardly conducive to efficiency in this wild country, where communications were both difficult and dangerous. It is therefore not surprising to learn that the vice-royalties themselves displayed a certain independence towards the central government, thereby sowing the seeds of that spirit of independence which later found full expression in the lives of such men as Bolivar and San Martin. From the vice-royalties originated the crude beginnings of Argentina, Bolivia, Colombia, Chile, Ecuador and Peru.

In the early nineteenth century, Bolivian independence was finally achieved, the first president of the newly formed republic being General Sucre, victor of the battle of Ayacucho, who ruled under the Constitution laid down by Bolivar; after two years the Sucre government was overthrown by a revolt of Colombian troops, who had been brought into the country during the war of independence against Spain. Thereafter, the further development of Bolivia was seriously hampered by a long series of revolutions, culminating in the rule of Andrea Santa Cruz, an ex-officer of the Spanish Army, which had fought against San Martin; a man of outstanding ability, he united Peru and Bolivia, proclaiming himself Protector of the United States of those two countries in 1836. A war between Chile and this combination resulted in victory for Chile, both on land and sea; in 1879 a further war against that country meant the loss of the coastline from Antofagasta to Arica, a region of valuable nitrate deposits and copper mines; this was an extremely serious matter for Bolivia, which thereafter became a completely inland country.

General William Miller

A remarkable Englishmen who took an active part in the achievement of Bolivian independence was General William Miller, an officer in the army of Bolivar; he was eventually appointed Prefect of the rich mining district of Pobosi, proving himself to be as able an administrator as he was a military leader. Domville-Fife* records how Miller was granted almost dictatorial powers, being simultaneously superintendent of the mint, director of the bank, and vice-patron of the Church. He was therefore credited with impartial judgment, being charged with approving clerical appointments sug-

*"Modern South America," by C. W. Domville-Fife. Seeley, Service and Co., Ltd., London, 1931.

gested by the Archbishop, and more than a hundred appointments for administrative posts. A man of high moral courage, he abolished many useless offices of the State and reduced salaries, including his own.

Miller was born at Wingfield, Kent. He served under Wellington in the Peninsular War; in 1817 he went to Buenos Aires in the service of General San Martin. Later he served under Lord Cochrane in Chile. He died under the British flag on board H.M.S. "Naiad," at Callao, in 1861.

No less famous during the early years of Bolivia's independence was another Britisher, Captain Andrews, agent of a mining company; he offered Bolivar one and a half million dollars for all the unappropriated mines of Upper Peru, but the Liberator refused his offer.

Modern Bolivia

Modern Bolivia is thus founded on a stormy past, in which wars and revolutions have had the effect of weakening its resistance so that it has become a landlocked state. Bordered by Brazil on the north and east, by Argentina and Paraguay on the south, and by Peru and Chile on the west, Bolivia is the fifth largest country on the continent, with an area of 420,000 square miles; it has often been picturesquely described as "The Roof of the World," about 6500 square miles of its area forming a plateau, or altiplano, some 12,000ft above sea level. This feature has a width of 86 miles, flanked on one side by the Cordillera Occidental and on the other by the Cordillera Real; the southern part of this great plateau is mainly desert, the northern part having the greater population. Here we have one of the world's greatest mountain ranges, the snow-clad peaks of Illampu, Illimani, Sajama and Chacacomani, all exceeding 21,000ft in elevation.

Like Chile, the country is divided into three climatic zones; in addition to the lofty altiplano, already described, there are the Yungas, or tropical valleys, north of La Paz, loftiest capital in the world. These lie amongst the spurs of the Cordillera at altitudes ranging from 2500 to 5000ft and drain into the Amazon. Then there are the Valles and Punas, high valleys and high plains. In the lowlands the average temperature is about 74 deg. Fah., whereas on the altiplano it is about 50 degrees; the western plateau is usually dry between April and November but wet for the rest of the year. It rains at all seasons in the eastern part of the country, with heavy rains from November to March.

La Paz, with a population of 300,000, is situated in a valley some 12,400ft above sea level. The principal towns, excepting Santa Cruz de la Sierra, in eastern Bolivia, lie at altitudes of from 8000 to 13,600ft. The estimated population of Bolivia, 3,200,000, is distributed as follows:

Indians	1,800,000
Persons of mixed breed	950,000
Whites, including 500 British	450,000

The Indians inhabit the altiplano, cultivating the soil with very primitive means and adding but little to the wealth of the country. As regards agricultural labour, we find that throughout the greater part of Latin America, the rural population lives in a condition of tenant-peonage, scarcely distinguishable from that of the serf in mediæval times.

Future expansion and development of Bolivian agriculture depends largely upon improved transport. Being a landlocked country, agriculture will have to concentrate on satisfying local needs; expansion can only come through an increase in population and in consumption per head.

Bolivia Development Corporation

The most significant recent development in the economy of Bolivia was the formation, on September 20th, 1942, of the Bolivian Development Corporation (Corporación Boliviana de Fomento). Its objective, as laid down in the charter, is "the development and exploitation of the natural resources of Bolivia and the development, increase and improvement of agriculture, mining, petroleum, forestry, and industry and commerce in general, and of transportation, as well as the construction of public works and others of general interest and utility within the Republic of Bolivia."

This Corporation is administered by a board of six directors, three from Bolivia and three from the United States. Every project must be submitted to the Export-Import Bank of Washington for approval. Its formation arose out of the findings of the United States Economic Mission to Bolivia, which made an intensive study of the whole problem of the country's economic structure, from December, 1941, to May, 1942, at the invitation of the Bolivian Government.

This Mission wisely suggested a long-term programme, having as its main objective a more stable and varied economy. This visualises the construction of eight highways, at a total cost of 40,000,000 dollars; the expenditure of 15,000,000 dollars on agricultural expansion; developing production of sugar, rice, timber, cattle, wheat and other cereals, dairy produce, edible fats and oils, cotton and wool; it is also proposed to spend 8,000,000 dollars on irrigation works and 25,000,000 dollars on the exploratory and development work necessary for petroleum production. It would appear that there are good prospects of developing the petroleum industry on the eastern slopes of the Andes, where Bolivia could obtain enough fuel for her domestic needs; in time she may be able to export appreciable quantities to Brazil, Argentina and Paraguay.

To meet these requirements, the Export-Import Bank has therefore extended a credit of 15,500,000 dollars to Bolivia, in return for which the Bolivian Government has agreed to deposit 3,500,000 dollars annually in the Central Bank for a period of three years. Although the authorised capital is not fixed, the Bolivian Government holds 45 per cent of the stock, the Export-Import Bank 50 per cent, and the remaining 5 per cent is issued to Bolivian institutions or associations.

Economic arrangements of this type are particularly interesting at the present time, when the United Nations are considering every practicable means of increasing the prosperity of relatively backward countries, especially those which depend mainly on one type of product or one group of activities. Any broadening of the basis of Bolivian economy should have a widespread and generally beneficial effect on the whole economic structure of Latin America, which for too long has been dependent for its soundness on a limited range of activities.

The Mining Industry

Mining is the chief industry in Bolivia, where tin bears the same relationship to the national economy as coffee does in Brazil, or wheat in Argentina. During the period from 1936 to 1940, minerals represented 94 per cent by value of Bolivian exports, with tin providing between 73 and 80 per cent. At the same time, Soule, Efron and Ness† point out that in spite of the importance of minerals to the national economy, they provide employment for only one-seventh of the population, as compared with two-thirds supported by agriculture. Nearly one half of the imports into Bolivia are agricultural products.

During the last half century the development of Bolivia has been closely linked with the rise of the mining industry, and it has been estimated that 70 per cent of the national revenue is derived from mining. No less than 56,000 persons are employed in mining.

Tamplin‡ has stated that Bolivia is unique among the countries of the world in providing this volume of employment from one industry in a population of more than 3,000,000. Although other countries may have mineral resources of equal or greater importance, they are not faced with such formidable physical and geographical difficulties precluding economic development of nearly every other potential source of national wealth.

Low Efficiency of Operation

This writer refers at some length to the largest tin producer in Bolivia, Patiño Mines and Enterprises, Cons., Inc., which continued operating for a number of years at a loss. From 1930 to 1935, inclusive, this concern paid no dividends and for three years of this period it operated at considerable loss; return on invested capital during the last 14 years, from 1930 to 1943, inclusive, averaged 6·17 per cent without compounding the interest annually. Based on compounded interest, return on the average capital of £4,914,984 was about 4·33 per cent. Tamplin shrewdly remarks that in no place in the world would this return be considered adequate on capital risked in a mining venture.

He quotes the case of the Patiño mines as being the most remunerative tin mining enterprise in Bolivia. According to the Congresso Nacional de Mineria, 1942 (Estudios y Recomendaciones), the main tin-producing companies of Bolivia, including the Patiño concern, averaged a return on the invested capital of only 0·91 per cent during the period 1932 to 1938, inclusive. He also states that an analysis of the tin mining industry in Bolivia would show that far more money had been put into the ground than has ever been removed in the form of profits.

Due to war conditions, he says, present tin prices are high throughout the world, but as far as tin producers in Bolivia are concerned there are three means by which the mining industry may be able to face future competition to better advantage than in the past, namely:—

(1) The form in which taxes are imposed should be modified in a manner which would stimulate and encourage increased activity.

(2) Increasing the efficiency of the Bolivian mine worker.

(3) Improvement of Bolivian metallurgical practice.

Although the Bolivian miner has been popularly represented as being miserably underpaid, Tamplin states that in fact he is better paid, better housed and better cared for than other classes of Bolivian labour. In comparison with mine labour elsewhere, he claims that the Bolivian worker is the

† "Latin America and the Future World," by Soule, Efron and Ness (New York, 1945).

‡ Article in "*The Mining Journal*" for October 14th, 1944, by William W. Tamplin, Technical Controller of Patiño Mines and Enterprises Consolidated, Inc.

highest paid and most expensive in the world, and concludes that the low efficiency of Bolivian mine labour is one of the chief contributing factors towards high operating costs in Bolivia.

Another writer§ referring to the difficulties confronting the Bolivian tin producers has stated that cost of production is high, due to the cost of transport down to the coast and the low grade of Bolivian concentrates. This not only increases smelting costs, but renders the process so awkward that the smelter in Texas, for example, accepts only 20 per cent of the total Bolivian deliveries of a grade lower than a tin content of 35 per cent.

An Improved Smelting Process

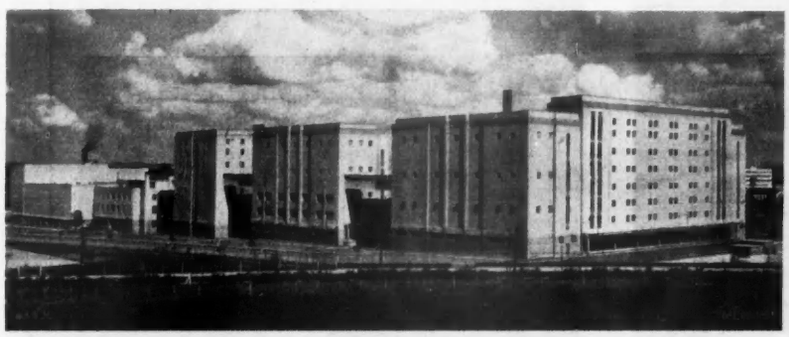
The Bolivian concern of Hochschild therefore approached U. C. Tainton, a Baltimore smelting expert, who built a commercial pilot plant with a capacity of 250 tons of ore per day operating on the Tainton system. The process is one of volatilisation and involves the capture of the volatilised tin in the form of oxide. It is claimed that this process will increase the tin production from low grade concentrates.

(To be continued)

Park Royal Brewery

A SHORT time ago we were invited to visit and inspect the brewery of Arthur Guinness, Son and Co., Ltd., at Park Royal, London, N.W.10, which, apart from the parent brewery in Dublin, is the largest of its kind in the world, embodying in its design and construction several interesting architectural and engineering features. As it forms one of the many installations to be visited by the members and guests of the Institution of Mechanical Engineers this week, during its Centenary Celebrations, some account of its buildings and its technical equipment will be of interest to our readers.

The business of Arthur Guinness, Son and Co., Ltd., was founded in 1759 by Arthur Guinness, who purchased the St. James's Gate Brewery, Dublin. It has descended in a direct line from father to son ever since, and was, in 1886, converted into a limited liability company by the first Lord Iveagh. Although it brews only stout, by 1914 it had become the largest brewery in the world. So much of the firm's output was sent to England that, after the 1914–1918 war, it became clear that it would be economical to establish a brewery in this country. In 1933 the Park Royal site was chosen and the work of construction was begun that year. Brewing was started in February, 1936. During the 1939–1945 war, the brewery was continually worked at an overload of nearly 100 per cent. Brewings at Park Royal have exceeded 36,000,000 gallons of stout in a year.



PARK ROYAL BREWERY MAIN BUILDINGS

The Park Royal Site

The site at Park Royal was chosen after a very careful consideration of the constructional, operational and distribution sides of the firm's business. It is linked with the Great Western Railway and the Grand Union Canal, and has good road transport facilities. The whole area of the site is about 130 acres and the main buildings, illustrated herewith, are built on an area of approximately 35 acres on the eastern half of an area of about 80 acres within the brewery boundaries. The land to the north and west is occupied by the staff houses and playing fields, &c., while there are housing sites for the brewery employees. The main buildings consist of five large monolithic blocks, which are built on a line running almost due north and south. The actual process of brewing starts at the south end, in the malt store, and it finishes in the racking vat house.

Architecture and Construction

The architect for the undertaking was Sir Giles Gilbert Scott, O.M., R.A., and the consulting engineers Sir Alexander Gibb and Partners, of Westminster. Messrs. McLellan and Partners acting as consultants for the power plant. The work was carried out under the general direction of the technical and engineering staff of the Guinness firm.

The engraving we reproduce shows clearly the five main buildings. The average height of the malt store, the brewhouse and the storehouse, shown to the right of our illustration, is 100ft, and it may be noted that the tops of these buildings have been kept in one plane, although the ground falls at a fair gradient from south to north, and in so doing, assists gravitational flow, thereby reducing the amount of pumping required. The main buildings are all supported on reinforced concrete piles which are 14in square, and vary from 35ft to 45ft in length. Owing to the nature of the ground, heavy piling was necessary and over 1500 piles were used on the malt store alone. They were constructed on the site and were driven after ten days. The main building work was done by Holland and Hannen and Cubitts, Ltd., and the foundation work was entrusted to Peter Lind and Co., Ltd.

In general, the plant and machinery is carried on a braced steel framing and a second steel framing, anchored to the main frame supports the brickwork, which forms the walls. The brickwork, with its yellow ochre shade of mortar and wide joints, has a warm and pleasing appearance; the lower courses of bricks are of rather a darker colour than the upper courses, and at first-floor level there is a deep fluted band of reconstructed stone, which surrounds each block. The doors and frames are, we noted, of teak or metal, and the buildings are of fireproof construction.

The Malt Store

Particular interest attaches to the construction of the malt store, which contains reinforced concrete storage silos or bins about 12ft in diameter, with a depth of 65ft. They were among the first to be built in this country on the moving form principle, with continuously poured concrete. They were built in fourteen days at an average speed of 5ft per day. The intervening spaces between the circular silos are also utilised for the storage of barley malt. The store contains 183 storage bins, having a total capacity of 245,200 barrels. The larger bins, of which there are 49, each hold 2000 barrels of malted barley. Bucket conveyors carry the malt from the point of entry to the screening, separating and weighing machines, and thence to the top of the malt house, where there is an automatically controlled system of belt conveyors, serving the various bins. Much of this fast-running conveyor plant was supplied by Henry Simon, Ltd., of Cheadle Heath, Stockport. The machinery is installed in the south side of the malt store and on the west front there is a large store for hops.

The Brewhouse

Between the malt store and the brewhouse and between other main blocks of buildings there are steel interconnecting bridges. The interior of one of these bridges is illustrated overleaf. Besides giving convenient accessibility, these bridges carry the conveyors for the brewing materials, water mains, electric light cables, and other brewery services.

The architectural treatment of the brewhouse is similar to that of the malt store, but owing to the high temperature at which several of the processes take place, the roof is constructed with timbered north lights, giving the necessary amount of ventilation. The offices in the brewhouse are air-conditioned.

The barley malt reaches the brewhouse on belt conveyors. There it is again weighed, ground in roller mills, and run into the mash tuns, see overleaf, where it is mixed with water at the desired temperature. In the tuns, the starch in the malt is partly converted into sugar, and partly into those substances which form the body and give a full taste to the stout. The liquor is finally drawn off through the slotted plates of the false bottom in the mash tun and then is pumped into large copper kettles or coppers. At this further stage hops are added to the wort or sweet liquor, and the two are again boiled together for a certain time to give the bitter flavour, and to extract

§ See "American Metal Market" for September 8th, 1944. "New Process Promises Better Recoveries from Bolivian Ores."

PARK ROYAL BREWERY OF ARTHUR GUINNESS, SON AND COMPANY LTD.

REFRIGERATING PLANT
GENERATOR ROOM

CONNECTING BRIDGE BETWEEN BUILDINGS
MASH TUNS

the conservative qualities from the hops. The spent malt and hops are sent to a special department, where they are made into cattle food and manure.

Storehouse or Fermenting House

The liquor from the brewhouse now passes to the storehouse, where, after it has been brought down to about 60 deg. Fah. by refrigeration, it ferments. The required amount of yeast is added to the wort on its way to the fermenting vessels or tuns, in which it remains for about three days. The breaking up of the sugar produces alcohol and carbon dioxide. Following fermentation, the beer is pumped into skimmers, in which the yeast rises, and is skimmed off. Part of the yeast thus formed is kept for future brewing and the remainder is dried and is sold for cattle food. In an annexe to the storehouse, in a central position, is the refrigeration plant, which, as shown in our engraving, opposite, is electrically driven. The single-acting high-speed CO_2 compressors, with the condensers and evaporators, were designed and supplied by J. and E. Hall, Ltd., of Dartford. There are eight refrigerating machines with a total capacity of 7,750,000 B.Th.U.s per hour. To deliver cooled water to various parts of the brewery, at temperatures ranging between 45 deg. and 65 deg. Fah., there are two 2,000,000 B.Th.U. capacity machines, and three 1,000,000 B.Th.U. machines. In addition, three machines, each with a designed capacity of 250,000 B.Th.U.s per hour, supply cooled brine at a temperature of 20 deg. to 30 deg. Fah.

Administrative Offices

Between the storehouse, where the fermentation takes place, and the vat house, for maturing and despatch, are the main administrative offices, which are spacious and beautifully appointed, air conditioning being used in the larger rooms. They contain excellent canteens and dining accommodation for the staff.

Vat House and Racking Shed

The "Guinness," which is now ready for maturing, passes from the fermentation house into the vat house, where it is collected in large vats of solid oak, in which it matures naturally. In this store we noted twenty-four large vats, each with a capacity of 43,000 gallons, and eight smaller vats of 32,000 gallons capacity, giving a total of 1,296,000 gallons. After maturing, the stout is passed for clarifying to another series of vats known as racking vats, and when ready for sale, it passes to the racking shed, where it is put into casks and sent to the trade. In conjunction with the racking shed is a cooperage, where casks are made and repaired by highly skilled craftsmen. The racking shed is situated to the east of the vat house and consists of a large covered asphalt floor, sloping from north to south. The casks are off-loaded at the south end and after cleaning and sterilising are filled and loaded at the north end, thus obviating the need for conveying plant.

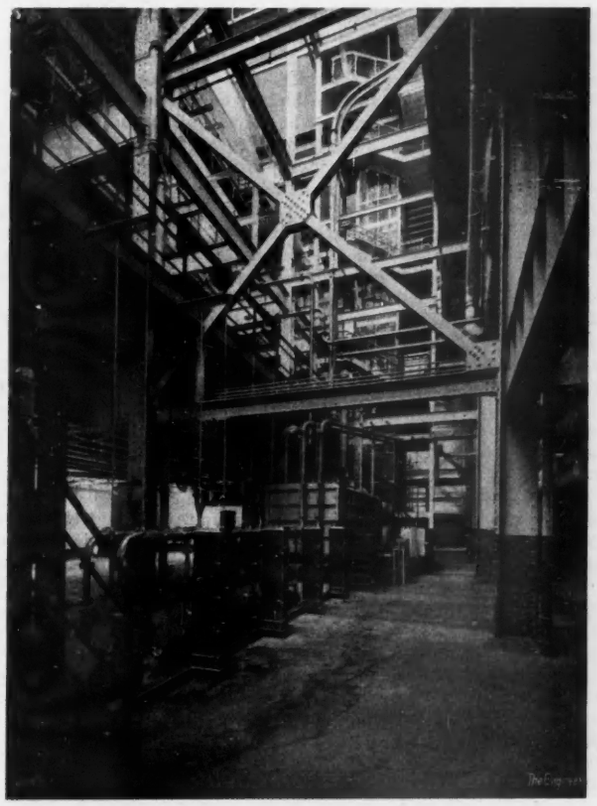
Power Station

The whole of the steam and electrical energy required by the brewery is generated in a central power plant, and we illustrate herewith the boiler house and the steam turbine room. The power house is a fine building with provision for further extensions, and there is a tall octagonal smoke stack.

The coal can be delivered by lorry, rail or canal, and it is dumped into the boot of a conveyor which delivers it to overhead bunkers with a designed capacity of 750 tons. The boilers are of the Babcock Wilcox type, with chain grate stokers, There are four of these boilers, each designed to evaporate 30,000 lb of water per hour at a pressure of 185 lb per square inch. They were originally designed for induced draught only and were fitted with Davidson fans and grit collectors, but superheaters and forced draught fans are now being fitted. The boilers are equipped with Green's vertical tube economisers of the specially reinforced Ringstay design. Each economiser is arranged in four groups with intermediate vertical baffles to give high velocity gas circulation. The machines are enclosed with insulated mild steel casing panels in place of the usual brickwork. The gases then pass to the smoke stack, which has a height of 163ft and a top diameter of 9ft 6in. The feed pumps, deaerators and feed heaters are of Weir construction.

In order to reduce the consumption of coal during the recent fuel crisis, a battery of oil-fired boilers was recently installed. They are of Lewis mobile water-tube pattern and are six in number, each having an output of 6000 lb per hour. Suitable oil storage tanks have been laid down. With these oil-fired boilers the coal consumption was reduced by approximately two-thirds.

The turbine house, shown opposite, contains four steam turbine-driven generators and a 30-kW oil engine-driven house set for starting up. All the plant was designed and supplied by W. H. Allen, Sons and Co., Ltd., of Bedford. There are two 500-kW and one 250-kW geared



Brewhouse Basement

Boiler House

back-pressure sets, which receive steam at 185 lb per square inch pressure from the boilers and exhaust it to the process steam mains at a pressure of 30 lb per square inch. The further 250-kW set is employed as a balancing unit, taking steam at 30 lb and expanding surplus steam down to 27½in vacuum. Redress in balance is secured by by-passing high pressure steam into the process mains if the pressure drops to 27 lb per square inch. For this purpose Hopkinson reducing valves are employed. The system of electric supply is three-wire direct current, with a normal voltage of 420 between the two outer conductors. The Whipp and Bourne main switchboard will be seen in our engraving.

We are indebted to Sir Hugh Beaver, M.Inst.C.E., M.I.Chem.E., the managing director of Arthur Guinness, Son and Co., Ltd., and to Mr. M. W. Plumpton, M.I.Mech.E., the chief engineer of the company, for the information and particulars on which this article is based.

The Possibilities of Nuclear Energy for Heat and Power Production*

By Professor J. D. COCKCROFT, C.B.E., M.A., F.R.S.†

The First Nuclear Reactor.—The first man-controlled release of "atomic energy" was achieved in December, 1942, when Professor Fermi and his co-workers assembled the first atomic pile or nuclear reactor in the squash court of the University of Chicago. This pile consisted of several hundred tons of rather pure graphite into which was inserted lumps of uranium metal and blocks of uranium oxide.

When about 6 tons of uranium metal had been inserted a nuclear chain reaction started and the reactor began to develop heat, derived from the splitting up of uranium atoms. Man had tapped a new power source of enormous potentialities.

Principle of Operation of a Nuclear Reactor.—Nuclear reactors are of two general types, known as fast and slow reactors.

The neutrons emitted in the fission process have energies between a few hundred thousand and several million volts. When a fission occurs in a large mass of uranium the neutrons produced will have a chance of producing further fissions by the fast fission reaction. They have also a fairly strong probability of being absorbed in U 238 to produce plutonium as an alternative to producing fission. Due to this latter factor, a fast neutron chain reaction cannot start in a mass of natural uranium. If, however, the lighter constituent of uranium, U 235, is separated from the absorbing U 238, a fast neutron chain reaction can be set up in the U 235. This is the principle of the atomic bomb. The slow reactor, on the other hand, makes use of the fission of U 235 by slow neutrons.

A slow reactor consists usually of bars of uranium metal in its natural proportions embedded in a mass of material known as the moderator, whose function is to slow down the neutrons to the velocity where they can produce fission in U 235 by the slow reactor—about 2×10^5cm per second. The first requirement for a moderator is that it must be made up of light atoms because a neutron is slowed down by making elastic—billiard-ball—collisions with the atoms of the moderator. The lighter the atom it collides with, the greater the slowing down effect. The second requirement for a moderator is that it should have a low absorption for neutrons. The third requirement is that it should have a high density since otherwise the neutron would have to travel too far between collisions and the size of the reactor would be very large.

Ordinary water would be the simplest moderator to try, but hydrogen absorbs neutrons too strongly and the chain reaction would not develop. Heavy water is the next possibility, and was suggested for this purpose by Professor Joliot-Curie and his colleagues in 1940. Heavy hydrogen was found to have a very small absorption for neutrons and heavy water has been proved to be a practicable moderator. Unfortunately, it is very costly—its pre-war price was £500,000 per ton. Nevertheless, many tons of heavy water have been produced—in Canada, United States and Norway—and at least three heavy water nuclear reactors are now operating.

The next possible moderators are beryllium and carbon. Beryllium is very scarce in Nature, but carbon in the form of graphite has been found to be very suitable, and most nuclear reactors so far built have used graphite as a moderator.

The Multiplication Constant and Critical Size of a Pile.—The development of a chain reaction in a nuclear reactor requires that one neutron producing a fission should produce more neutrons of which at least one should survive to produce a second fission. A small number of neutrons are continuously produced in uranium by spontaneous fission. Assume that one of these neutrons enters a U 235 nucleus in the metal rod of the pile and produces a fission. This leads to the emission of η neutrons, where η may be greater than 2.

These fission neutrons are fast and have energies between a few hundred thousand volts and three or four million volts. Before they leave the metal rods they have a small chance of producing fission by the fast neutron fission process. Their number will therefore on the average be increased to $\eta\xi$. They now enter the graphite, and, in colliding with the carbon atoms, lose one-sixth of their energy in each collision. After about 200 collisions they are slowed down to a speed of about 2×10^5cm per second—the so-called region of thermal energies (the average energy of a molecule of hydrogen gas at room temperature). When they reach these speeds the neutrons are able to produce fission by the slow fission process in U 235 atoms. Not all of them reach these energies, however. Some of them are swallowed up by any structural materials in the pile. If a fraction p_1 survive this, we are left with $\eta\xi p_1$. Others of them are captured by U 238 to form plutonium. If a fraction p_2 survive this capture process, we are left with $\eta\epsilon p_1 p_2 = k$ neutrons produced by one initial neutron.

Suppose that the multiplication constant k is just less than unity. Then one primary neutron produces $1+k+k^2+k^3+\ldots$ neutrons or $1/(1-k)$ neutrons.

Thus as k approaches unity one neutron will produce a chain of very many more, but the chain is convergent. If $k>1$ then the series is divergent and one neutron would produce an infinite number of neutrons in a pile of very large size.

If, however, the pile is small, many of the neutrons will escape before they can produce more fissions. They may travel as much as a foot in a graphite pile between birth and death—this distance M is called the migration length. A pile must therefore be over a certain critical size before the chain reaction can develop. By taking account of the fact that neutrons born at a distance M from the face of the pile will be likely to escape, it is possible to show very simply that the critical linear dimension a is proportional to $M/\sqrt{k-1}$.

At the critical size the proportion of neutrons escaping is such that the effective k is $k_{eff}=k-k_{leakage}=1$.

The pile is then in equilibrium and the neutron density will remain constant.

Control.—The next important question is the method of control of a pile. We may imagine that for a pile in equilibrium—with k just equal to unity—some movement of the system may change the amount of absorption and therefore make $k=1+\delta$, where δ is small. This would lead to neutron multiplication. At first sight one might think this would be very rapid, since the time of a neutron generation—birth to death—is of the order of 10^{-3} seconds, and so in a second we should get 1000 generations of neutrons and a consequent very rapid build-up of flux. Very fortunately, however, control is made possible by a lag in the emission of neutrons after fission. About 1 per cent of the neutrons are delayed by quite appreciable times—of the order of a minute in some cases.

If therefore k jumps to 1·01, the additional 1 per cent which brings multiplication will be born up to a minute late and this provides the system with a most desirable inertia. If, in fact, one winds out the control rods of a pile just a little, the power level of the pile will increase exponentially, but with a very long period—of some minutes. Having raised the power level to its new value, the control rods are wound back and the power level stabilised. In equilibrium the level of power can easily be kept constant to within 1 part in 10,000.

Safety.—In addition to control rods to provide for stable operation, it is necessary to provide emergency measures to prevent the pile from running away due to faulty operation.

The level of power at which the pile is operating can be measured in a variety of ways—by an ionisation chamber to measure the neutron flux or by a thermometer to measure the heat developed. Indicators of this type are connected up by relays to operate safety rods containing a strong neutron absorber such as boron. These rods are driven quickly into the pile by springs or compressed air at any prefixed level of power.

Heat Generated in a Pile.—The energy released in a pile appears in the first instance as the kinetic energy of the flying fission fragments, together with the energy of gamma rays emitted in the fission process and subsequently from the fission products. These fission fragments come to rest in the uranium metal rods and their energy is there converted into heat. The gamma rays are absorbed in the metal or graphite and contribute their quota of heat.

If a pile is burning up 1 gram of U 235 a day by fission and each fission releases 200MV of energy, a simple calculation shows that the pile generates heat at a rate equivalent to 1000kW. The power level

* James Clayton Lecture, Institution of Mechanical Engineers, June 10th. Abstract.

† Director, Atomic Energy Research Establishment, Ministry of Supply, Harwell, near Didcot, Berks.

at which a pile can operate depends solely on the rate at which heat can be removed. If the pile is uncooled save by convection, then the power level could not exceed about 50kW without overheating of the uranium metal rods. The first pile to operate at Harwell will work at about this level.

The power extraction can be increased by blowing air past the rods—in this way the power can be put up to several thousands of kilowatts. The second Harwell pile will operate at this level. A next step is obviously to cool by compressed gas. An alternative, and the method the United States adopted in high-power piles at Hanford, is to water-cool the uranium rods.

Radio-Activity.—A pile generating 1000kW and burning up 1 gram of U 235 per day is destroying by fission 3×10^{16} atoms per second. This means that at least this number of gamma ray quanta are being emitted, and at the same time 6×10^{16} fission product atoms are born, most of which are radio-active. In the course of time, as many of these atoms are destroyed by emitting electrons as are created.

Immediately after shut-down of a pile, which has been running for a long time at a power of 1000kW, we will therefore have 6×10^{16} atoms per second breaking up by emission of electrons and quanta. This is an activity equal to that of 2,000,000 grams of radium and it has three results.

First, we must surround the pile with a shield of concrete or other material to absorb the harmful radiations, and protect the operators; 1ft of concrete reduces the intensity of neutrons and gamma rays by a factor of 10.

Secondly, even after shut-down we have a high radio-activity and generation of energy, and cooling cannot be immediately dispensed with.

Thirdly, the radio-activity of the fission products dies away gradually, and even after a year will still be of the order of 6000 grams of radium. Other parts of the pile structure become radio-active, and it is not possible to obtain access to the interior after it has operated.

Types of Piles.—Piles so far built have used either graphite or heavy water for slowing down the neutrons. Heavy water piles have a larger k than graphite piles, and so, since the linear dimension $a \propto M/\sqrt{k-1}$, they are smaller and give a larger neutron flux for a given size. Much more compact piles can be built by the use of uranium, in which the U 235 isotope is enriched. In such a system k can be substantially increased. The piles can be made smaller with a resultant greater freedom in design results. The limit occurs if one has available pure U 235 or pure plutonium. In this case a pile can be made by a few hundred grams of the material in a few litres of water. This small quantity of the fissile element might then develop 100kW for ten years.

Such piles will probably find a considerable use as research reactors in the future, owing to their high neutron flux, which depends on power per gram of fissile material.

The Use of Natural Uranium Piles for Power Generation.—If we consider a pile constructed of natural uranium, it might at first sight appear that the pile would continue to operate until all the U 235 was burnt up. We cannot, however, assume that we can burn up just the U 235, but for generality we should assume that X times its heat content can be obtained. The important question arises as to what is X.

It is determined by four main factors:—

(*a*) A U 235 atom destroyed by fission emits between one and three neutrons. One of these replaces the original neutron; the remaining neutrons are either wastefully absorbed in structural materials and impurities or produce plutonium atoms. On the average each primary fuel atom of U 235 is replaced by Y secondary fuel atoms of plutonium, where Y will on the average be approximately unity. This secondary fuel atom can in turn be destroyed and the single neutrons again used to produced Y^1 tertiary fuel atoms, and so on.

These partial replacements of fuel atoms mean that in principle we can utilise more than the fission energy of the U 235.

(*b*) Fission products accumulate in the uranium metal and their additional absorption will decrease the multiplication constant k.

(*c*) Changes may occur in the crystal structure of uranium metal and moderator.

(*d*) Because of (*b*) and (*c*) the uranium metal rods have to be withdrawn at intervals, the fission products extracted and the uranium remade into metal. During this process some portion of the fuel atoms will be lost. We do not at present know how many cycles of purification the metal will have to undergo.

For these reasons X is at present uncertain within wide limits and it may well be greater than unity.

The power development which could be obtained from an annual consumption of 100 tons of uranium will now be calculated. This consumption leads to a burning of $100\times10^6/140\times365=2000$ grams of U 235 per day. This would provide a continuous heat equivalent of $2000\times1000\times X$ kilowatts, or an annual output of $1{\cdot}7\times10^{10}\ X$ kilowatt-hours.

Assume that we could obtain a thermal efficiency of 30 per cent, this could provide $1{\cdot}7\times0{\cdot}3\ X/4{\cdot}3=0{\cdot}12\ X$ of our units generated (1946 U.K. electricity output$=4{\cdot}3\times10^{10}$ kilowatt-hours).

Principles of Construction.—In most nuclear reactors built so far the rods of uranium metal have been sheathed by aluminium to prevent corrosion of the metal and to prevent escape of the radio-active fission products into the coolant. Aluminium has been chosen because of its low neutron absorption. Piles built for power generation will probably use a coolant of high-pressure gas in a closed-circulation system. This gas must have a low neutron absorption and might be either helium or carbon dioxide. The coolant would be passed through a boiler to raise steam, directly through a gas turbine, or used to heat a secondary fluid in passing through a heat exchanger. For these purposes a high exit gas temperature from the pile is desirable.

If aluminium sheathing is used, the temperature will be limited by the safe stress of the metal from the point of view of creep. The maximum exit gas temperature would then be of the order of 300–400 deg. Cent. (570–750 deg. Fah.). It is probable, however, that future developments will remove this limitation by using sheaths of other low neutron-absorbing materials, such as refractories, which will withstand higher temperatures. It is not unreasonable therefore to assume that a thermal efficiency of the order of 30 per cent will be reached.

Practical Realisation.—It seems probable that a nuclear power generating station designed round a natural uranium pile using aluminium sheathing could be built within three or four years to generate power at an efficiency of 15 to 20 per cent.

We could make a reasonable estimate of the capital cost, but could not estimate the operating life of such a system. Operating costs are subject to even greater uncertainties, owing to our lack of knowledge of the amount of metal recycling required. Only operational experience can provide the answer to these questions. We might, however, reasonably expect that a pile of this kind will be the first step towards the practical utilisation of nuclear energy. Subsequent piles might first increase the operating temperature, and, secondly, make use of breeding to improve the overall utilisation of uranium.

In the course of this work we shall have to solve the problem of the disposal of radio-active fission products, which would be produced as a by-product in very large intensities. These products can be a serious danger to health if they are dispersed in concentrated form. Although a good deal has been determined about the safe concentration, much remains to be determined by medical research. The chemical engineer will no doubt make an attempt to concentrate these products and to use their heat and radiative energy.

We might reasonably expect that we shall require at least one decade to solve these technical problems, and that within the second decade we should be in a position to design nuclear power units which would begin to make some contribution to our fuel supplies.

"Lincoln II" Bomber with Propeller Turbine Engines

IN February last a "Lincoln II" aircraft, with Bristol "Theseus" gas turbines driving the two outer propellers, took off from Filton aerodrome. This, the first flight of a British gas turbine specifically designed for driving an aircraft propeller, took place little more than eighteen months after the "Theseus" ran for the first time on the test bed, and only seven weeks after this engine achieved the distinction of being the first aircraft propeller turbine in the world to pass a full official type test.

That was, however, only the beginning of an intensive programme of flight development work in this "test-bed" aircraft, during which handling, performance and safety are being investigated before the "Theseus" is released for installation in civil air liners, notably the Handley-Page "Hermes V."

We were recently afforded the opportunity of inspecting this "Lincoln II" at the Filton aerodrome of the Bristol Aeroplane Company, Ltd., and of taking part in a short trial flight. Take-off was with all four engines, but as soon as altitude was gained, the inboard "Merlin" power plants were shut off and the aircraft was flown on the gas turbine units only. This procedure permitted a comparison to be made of flight on reciprocating engines and on gas turbine units. As we were led to suppose, the contrast was marked. Vibration and noise—particularly vibration—was reduced to a remarkable extent, even though the aircraft was a Service type and not soundproofed in any way. Travelling was by comparison luxuriously smooth and effortless, and the flight demonstrated in a convincing manner what this new development can do for the civil air liner. Progress in engineering is not always so. For example, the oil engine in commercial vehicles, though economical, is rough and noisy by com-

parison with the petrol engine which it has displaced.

"Theseus" Installation

Although the installation of the "Theseus" in the "Lincoln" has been dealt with as part of the Bristol Company's normal procedure for development testing of new types of engines, it is of interest to note some special points. As is widely known, the "Lincoln" is a four-engined heavy bomber of 120ft wing span, with an all-up weight of 75,000 lb and a crew of seven for normal military operation. Its selection for the initial flight testing of the "Theseus" was based upon its performance at altitude, and the ample fuselage space available for flight observers and their equipment. This aircraft, with its gas turbine propeller units, is illustrated herewith.

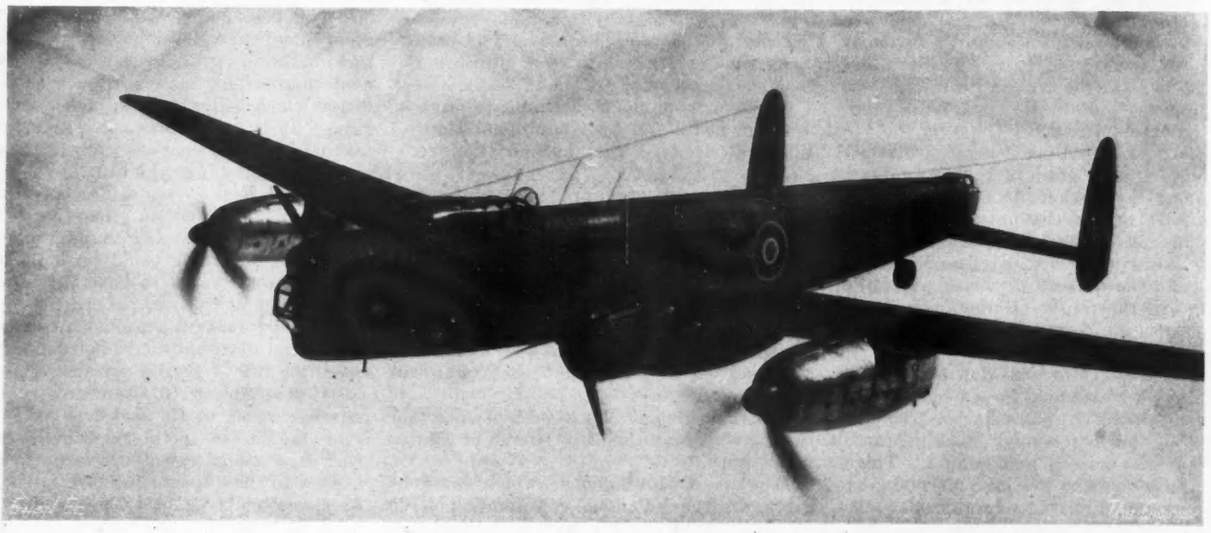
The outboard "Merlin" power plants and nacelles were removed entirely. New nacelle structures were designed and made for attachment to the existing brackets on the wing spars, with four pick-up points to suit the gas turbine power plants. The geometry of the new nacelle structure had, of course, to allow for the installation of the jet pipe and the discharge of the gases clear of the wing with flaps down. Due to the thrust line requirements, the nacelle could not be slung low enough to permit a horizontal jet pipe, and the pipe is therefore inclined downwards at about 15 deg. It is provided with a controllable flap to permit the orifice area to be varied.

The "Theseus" power plant was fully illustrated and described in THE ENGINEER of September 20th, 1946. It is built on a triangulated steel-tube mounting structure, supplied as standard engine equipment, and is divided into bays by two fireproof bulkheads. As shown in an accompanying engraving, the foremost of these bays lies immediately behind the main engine mounting beams, and the other at the rear between the power plant and the nacelle structure. Thus the high-temperature regions of the engine, comprising the combustion chambers and the turbine casing, are isolated between the two bulkheads, and the oil tanks, oil cooler, oil pumps and fuel pump are isolated forward of the front bulkhead. All electric leads between the two bulkheads are encased within a duct, which is ventilated from an opening in the nose cowl.

The oil tank is of 15 gallons' capacity and the oil cooler only 6in diameter, since the lubrication requirements are only a fraction of those of a reciprocating engine of equivalent power. The cowling follows normal Bristol practice, with hinged panels secured by quick-release toggle fasteners to facilitate inspection. The whole power plant and nacelle arrangement is compact, symmetrical and of good aerodynamic form.

Comprehensive instrumentation is incorporated in the port installation, and to a more limited extent in the starboard one, for recording a wide range of observations of the engines in flight. With the exception of this special equipment and certain electrical control boxes, the port and starboard power plants are interchangeable.

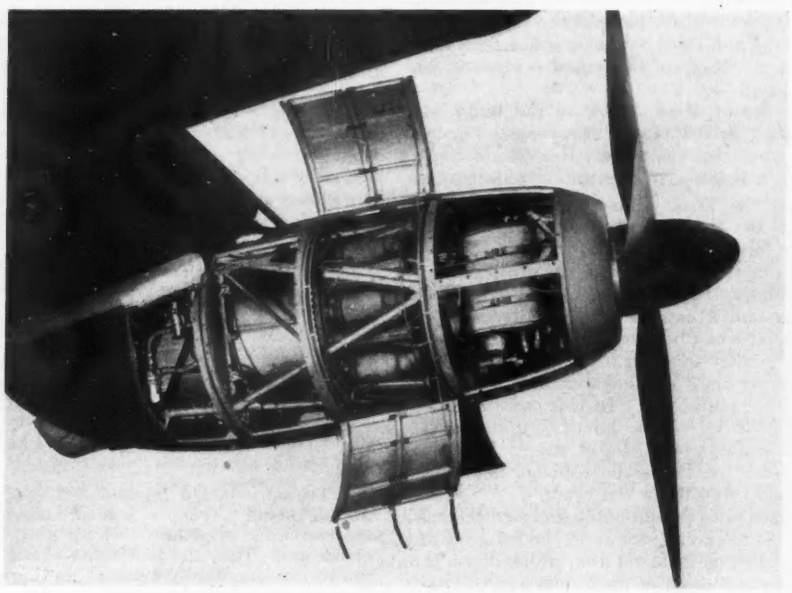
Numerous detail alterations in the airframe were, of course, necessary, including the rearrangement of the fuel system. The intermediate and outer tanks in each wing are used for kerosene for the gas turbine units, leaving the inner tanks for petrol.



"Lincoln II" Bomber Flying on Outboard "Theseus" Engines

Power Cycle

The accompanying diagram represents a longitudinal cross section of the "Theseus," with the propeller at the left. It will be seen that air enters the engine by an annular air intake just behind the propeller, and immediately passes into an axial flow compressor. The latter consists of a rotor carrying nine rows of blades, spaced between stationary guide blades mounted around the inside of the compressor casing. After compression through these stages the air enters the eye of a centrifugal impeller for a further stage of compression, and at the same time is directed radially outwards through a diffuser to eight air transfer ducts arranged longitudinally and equally spaced around the outer periphery of the engine. Further to the rear, these ducts are connected to the air inlet headers of the heat exchanger, a drum-shaped assembly of longitudinal tubes separated by air passages. Exhaust gases from the turbine are discharged through the longitudinal tubes, and in so doing transfer some of their heat, which would otherwise be wasted, to the air passing radially inwards between the tubes, and then outwards again to air outlet headers which deliver the heated air to eight combustion chambers. Here kerosene fuel is injected through fuel spray nozzles at the rear of each combustion chamber. For starting purposes two of the combustion chambers are fitted with igniter plugs and the other chambers are connected by tubes through which the flame flashes and ignites the remaining spray nozzles.



"Theseus" Engine Installation

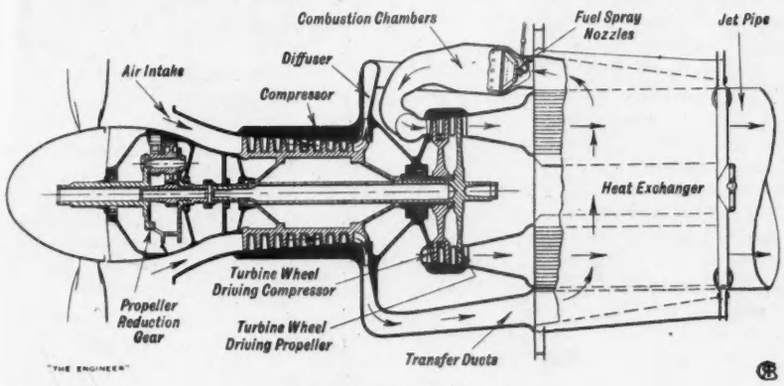
From the forward ends of the combustion chambers, the gases are directed through tangentially sweeping tubes to the turbine casing, which is a self-contained unit containing two turbine wheels. The foremost wheel drives the compressor, and is the first to receive

the gases from the combustion chambers. It has two stages of blading, each preceded by stationary guide blades carried in the casing. After having delivered some of its energy to this compressor driving turbine wheel, the gas stream is directed by a third set of guides on to the blades of the separate turbine wheel which drives the propeller. This wheel is bolted to the rear end of a long shaft, which passes forward inside the compressor rotor to a propeller reduction gear, which is housed within the air intake casing at the front end of the engine. This gear gives the propeller a speed just over one-ninth of that of the turbine wheel. There is no mechanical connection between the two turbine wheels, but their relative speeds are governed by a special device. At maximum power conditions, the propeller-driving turbine wheel rotates at 9000 r.p.m., and the compressor-driving turbine wheel at 8200 r.p.m.

Leaving the propeller-driving turbine wheel, the exhaust gases pass through the tubes of the heat exchanger, as already described, to the jet pipe. This pipe is designed to suit the particular aircraft, and may have a single, direct outlet or twin outlets straddling the undercarriage housing or any other obstruction in the nacelle or fuselage. The outlet or outlets may have a controllable flap to vary the area of the exit orifice for best thrust efficiency in different conditions of flight.

The above description relates to the "Theseus" series TH.21, the power output of which at sea level, with the aircraft stationary, is 1950 b.h.p., plus a thrust of 500 lb from the jet. At 300 m.p.h. at sea level, the total power, including the jet thrust, is equivalent to 2380 b.h.p., whilst at the same speed at 20,000ft altitude, it is equivalent to 1500 b.h.p. The fuel consumption at the latter condition is only 0·53 lb per equivalent b.h.p. per hour. The dry weight of the complete engine, including the mounting tube unit, is 2310 lb.

The "Theseus" series TH.11 is identical in design, except that the heat exchanger is omitted, reducing the weight to 1860 lb. This version is intended for shorter routes, where the heat exchanger would not save enough fuel to compensate for its own weight. The sea level static power is 2180 b.h.p., plus 600 lb jet thrust, equivalent to 2700 b.h.p. at 300 m.p.h. at sea level. At this speed at 20,000ft, the equivalent power is 1680 b.h.p. and the fuel consumption 0·62 lb per equivalent b.h.p. per hour.



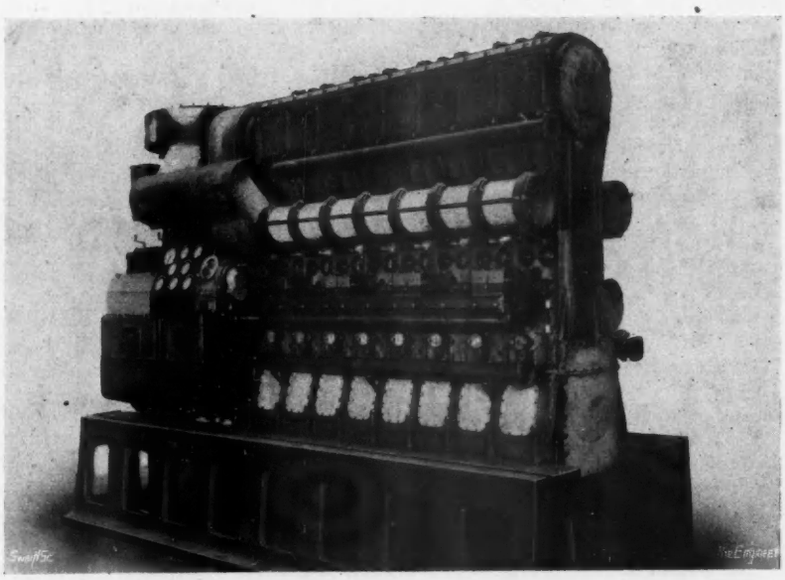
AIR FLOW DIAGRAM

Oil Engine and Gas Turbine Developments at Winterthur

DURING a recent visit to the works of Sulzer Brothers, Ltd., at Winterthur, we saw running on the test bed a new type of supercharged opposed-piston two-stroke oil engine. It has been specially designed for drives requiring high concentration of power. At present only brief details of this new engine are available, but we illustrate it in the accompanying engraving.

The following are the principal dimensions and particulars :—

Type of engine	8 G18 supercharged opposed-piston two-stroke
Designed output	2500 b.h.p.
Number of cylinders	eight
Bore of cylinders	180mm
Piston stroke	225mm
Running speed	1000 r.p.m.
Supercharging pressure	2·5 atm. abs.
Weight per b.h.p.	8 lb



2500 H.P. SUPERCHARGED OPPOSED-PISTON TWO-STROKE ENGINE

The engine has a welded casing and the supercharging unit comprises an axial compressor and an exhaust gas turbine. In later designs the axial compressor may be replaced with advantage by a radial compressor. The cylinder liners have double walls, so that a water jacket is provided. The cooling water is not, however, in contact with the welded cylinder block at any point, so that the 4mm plate of which the cylinder block is made cannot rust or be otherwise corroded. We look forward to giving a fuller technical description of this interesting engine at a later date.

It will be recalled from the paper read by Mr. James Calderwood, of Sulzer Brothers (London), Ltd., before the North-East Coast Institution of Engineers and Shipbuilders in April, 1946, on "Some Researches on Internal Combustion Prime Movers," which was reprinted in THE ENGINEER from May 10 to June 7, 1946, that Sulzer Brothers, Ltd., investigated many possible lines of development of the diesel engine, and, in particular, the high supercharging of the two-stroke engine, which was tested in all aspects, in a series of basic experiments. In following up the logical line of development, the firm also thoroughly examined the free-piston gas turbine plant, which is a special embodiment of two-stroke supercharging, in the form of a 6000 h.p. experimental plant. At the time when this plant was developed, heat-resistant steels, such as are used to-day for gas turbines, were not available, and the gas turbine process with free piston gas producers offered the possibility of realising a gas turbine plant with a good efficiency, while keeping the gas temperatures at the turbine within practicable limits.

In the subsequent tests it was proved, however, that the combination of the outputs of a number of free-piston units and their allocation to one turbine made considerable demands in the way of control and regulation, which would have led to complications not customary in merchant vessels.

Investigations up to the present also seem to show that the advantages of the free-piston gas turbine plant as a whole, in the power range of merchant ships, are probably not sufficient to make this type of prime mover a serious competitor for the diesel engine or the pure gas turbine. This and other considerations have led Sulzer Brothers, Ltd., to give priority to the pure gas turbine with a combustion chamber and it is therefore concentrating on its development. In this direction a 7000 h.p. marine plant operating on the Sulzer high-power cycle is already in hand and will be put on the test bed in the course of the year, while work has also been started on a 20,000-kW stationary plant for an electric power station, which will be installed at Weinfelden, in Switzerland.

LIGHTING IN INDUSTRY.—The Electric Lamp Manufacturers' Association has published a memorandum on lighting in industry. It deals with the principles of good lighting, present factory lighting standards and practice, and lighting recommendations. Appendices to the memorandum include an explanation of technical terms, notes on lamps and lighting costs, and information concerning colour in industry. The memorandum, it may be remarked, is based on a report submitted by the E.L.M.A. Lighting Service Bureau to the various working parties set up by the President of the Board of Trade. It was felt, however, that the observations and recommendations made would be of assistance to those concerned with industrial management in assessing the merits of their own lighting installations and of lighting schemes under consideration.

THE ENGINEER

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NOTICE TO READERS

All letters intended for insertion in THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

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For Subscription Rates, see page 2 of Advertisements.

A GREAT CENTENARY

THIS week the Institution of Mechanical Engineers devoted to the celebration of its foundation one hundred years ago. We do not propose to review here its history. That has been done by the President and others during the past few days in speeches and has been recorded with great wealth of detail in the altogether admirable centenary volume from the pen of Mr. R. H. Parsons, which we review on another page. It is sufficient to recall now that the Institution came into spontaneous existence, if we may so put it, in Birmingham in the early months of 1847, and that for a good many years it remained a local body with widespread interests. But it was destined for a higher position. It moved to London in 1877 and rapidly began to grow in strength and influence. Never at any time in its subsequent career did it suffer a check. It went forward steadily and continuously, not growing only in wealth and membership, but in reputation and esteem. To-day it numbers well over 24,000 members, including the accession that has followed the amalgamation with the Institution of Automobile Engineers. How little can the small party of men who drank its toast at the inaugural banquet in Birmingham have foreseen what a beneficent giant they were bringing into the world.

It was perhaps fortunate that the Institution had the noble example of the Institution of Civil Engineers to guide its early steps as a metropolitan society. But is it not fair to see in the readiness with which it adopted the principles of the older body evidence that the mechanical engineers of Great Britain could hold as exalted ideas about public service and public duties as their civil brethren? It must not be forgotten that at this period, roughly a century ago, the civil engineer regarded himself, and was regarded by society, as a cut above the mechanical engineer. The difference may be briefly expressed as that between one who accepts a fee for his services, a professional man, and one who sells goods for a price, a tradesman. Against that distinction, subtle but nevertheless effective, the Institution has prevailed and to-day the status of the mechanical engineer is as high as that of the civil engineer or of the member of any other profession. Let us say here, very specifically, that we are not thinking of status measured by salaries. The Institution has sought a higher level than that. Even in the years when it was only "Incorporated," it set itself against the slightest trace of trade unionism, and when in 1930 it secured a Royal Charter it accepted the condition that it must work only for the interests of the science and profession of engineering, and not for the individual benefit of its members. Occasionally there have been revolts, small affairs, against that policy. Young members who had not yet become imbued with the spirit of the Institution thought they had a right to demand that something should be done specifically for them in return for their fees. They failed, for a time, to see that the higher course that the Institution was taking did, in fact, benefit them individually because it raised the standard of mechanical engineering as a whole. In later years the revolters saw the matter in a better light, and recognised that it was their duty and privilege to bring something to the Institution, to give freely of their experience, so that all might profit thereby, and that their own personal interests were of far less consequence than the welfare of mechanical engineering. It is because that spirit, the spirit of professional co-operation, has prevailed throughout the years that the Institution, in this the opening year of its second century, is able to look back upon its works and with just pride say "Well done!"

It is natural and usual at the end of some notable period not only to review what has been achieved, but to glance forward at the coming years. The history of an institution forms the foundation upon which it stands. If it is sound, the superstructure may without danger be carried to unlimited dimensions. And it may be fairly said of the Institution of Mechanical Engineers that its foundations are solid enough to carry any weight that the future may impose upon them. The tenor of engineering is changing. Mechanical engineering has become a science, and those who pursue it are now called scientists. But the change does not cease there. Engineers now recognise more fully than ever before that they have a duty and responsibility towards the public, that they play a great part in the corporate life of the nation, and that through them and their works the peaceful development of the world may be hastened or delayed. This philosophic spirit which is moving in the whole profession will, we are confident, bring in time the greater Institutions into closer bonds than those that now tie them together, and so enable them to hasten, by corporate action, the realisation of the great destiny to which they are moving. Long before the Institution of Mechanical Engineers came into existence, Voltaire wrote: "We may believe that industry will always progress more and more; that the useful arts will be improved; that of the evils which have afflicted men, prejudices, which are not their least scourge, will gradually disappear among all those who govern nations, and that philosophy, universally diffused, will give some consolation to human nature for the calamities which it must always experience." Is it too much to hope, to believe even, that the learned societies of Great Britain, the Institution of Mechanical Engineers holding an honourable place amongst them, may play a part of no small consequence in bringing about a consummation so devoutly to be wished?

THE FUTURE OF THE AIR ARM

DISCUSSIONS in Parliament and in the Press have shown how difficult it is in these days to see at all clearly the future form which the Air Arm will need to take in order to remain one of this country's chief means of defence against attack. Much must depend upon whether the United Nations succeed in the effort towards complete banning of the atom bomb, as well as of other weapons of mass destruction, for if an absolute ban could be brought into existence, the development of the Air Arm could proceed on what may be called normal lines. But, as in the frailty of human affairs, there may fail to be created a reasonable certainty that all countries will so act as to justify confidence in their good faith, many governments will feel bound, as trustees of their people, to take such precautionary measures as common prudence may dictate. New means of aggression, whether they aim at one form of mass destruction or another, are likely enough to use aircraft as carriers, in which case the defending Air Arm would have the task of detecting and destroying them before they came anywhere near their intended targets. Owing to the deadly effectiveness of the newest forms of such weapons once they do reach the target, the defence must aim at finding some way to destroy, or divert, all or almost all, such carriers as may cross the coast-line. This problem with all its forbidding complexity is inevitably set to the air staffs of this as of other countries. It is as though the V.1 "bumble-bombs" of a few years ago had carried an immensely more potent warhead than they did and had travelled at double the speed. Against the V.1, as it then was, it was in the end found to be a not impossible task to destroy nine-tenths of those arriving. But by what means could the same be done against similar weapons coming at 500 or 600 m.p.h.? And, if it were, would even that casualty rate prove sufficient if the warhead were an atom bomb? Such are some of the defence problems that have now to be faced.

The original tasks undertaken by the Air Arm began in World War I with simple reconnaissance duties and passed gradually to fighting, bombing, torpedo-carrying and

anti-submarine work. In World War II these duties were all raised immensely in scope, especially that of area bombing. Goering had boasted that for every bomb dropped in Germany ten would reach enemy countries, but in the end the ratio was the other way about, and German economy was so disrupted that the unexpected duty of its rehabilitation fell on the victor countries —most heavily in proportion on Britain— as a kind of inverted war indemnity. The question is thus raised whether intensive area bombing is an intelligent way of waging war, and the same question in even more pointed form might well be thought to attach to atom bombing. Some may urge that it could not now ever be worth while for an aggressor nation so to attack another, for the greater the success of his onslaught the vaster the damage and the heavier the burden placed on any "successful" aggressor who took the attitude we take to a beaten enemy. But would he take that attitude? Although it is sometimes held that atom bombing is no worse than normal bombing, since the cities of Hiroshima and Nagasaki were no more damaged than scores of others in Japan and elsewhere, this conclusion is unsound, since even if the material damage was much the same, the casualties to persons were very much greater because the attack came on all parts of the city at the same time, so that one part could not go to the assistance of another. For the medical and hospital services, like the fire-fighting services, were all of them immobilised at the same time. And, added to this material destruction there was the new radioactive peril, as well as a direct heat wave, of unexampled intensity, radiated from the bomb at the moment of explosion. In this heat wave we see for the first time a "death ray" of the true H. G. Wellsian type, and it is conceivable that the counter to the use of atomic energy may some day be found in atomic energy itself, on the principle of the "hair of the dog."

If carriers of atom bombs are winged, they must be dealt with chiefly by the Air Arm, and in view of their speed, counter action will create a new important task for that Arm. They may even come at supersonic speeds, speeds at which no living pilot has yet flown. If they come as wingless, long-range rockets, their paths will be almost wholly beyond aircraft altitudes and their speeds far too high for Air Arm interception. It seems however that such rockets, if they are to have transocean ranges, are so difficult to design as to be far distant possibilities rather than a present menace. Those with wings are an easier task to design, but they depend on having a long gliding path in the atmosphere, and can therefore be got at by interception methods of one sort or another. It seems a justifiable conclusion, therefore, that in the coming days there will be ample scope for the defensive side of an Air Arm, although some of its duties may be of distinctly novel type. The aircraft it will need to employ will in many cases be much smaller in size than those to which we have been accustomed, but they will be of greatly higher speeds, and provided, it may be assumed, with means of self-guidance toward the target as well as of lethal action by proximity fuses or similar automatic means. It will be a heavy task for the air staffs to plan such novel air fleets, and an arresting challenge to the ingenuity of the engineer to provide them.

Centenary of the Institution of Mechanical Engineers

No. II—*(Continued from page 498, June 6th)*

THE Centenary Celebrations of the Institution of Mechanical Engineers began in London on Sunday last, June 8th, and will be concluded this (Friday) evening. Those taking part in the celebrations include 839 members, 84 delegates from other societies and organisations in this country and overseas, and 470 ladies, and the precision with which the extensive programme of meetings, visits and social functions has been carried through has undoubtedly emphasised the efficiency and care which the various organising committees and the Institution staff have shown in the discharge of onerous duties.

The first event in the week's programme was the Thanksgiving Service held in Westminster Abbey on Sunday afternoon last. This service attracted a very large congregation, and the preacher for the occasion was the Dean of Canterbury, the Very Rev. Hewlett Johnson, who before taking Holy Orders was for some years engaged in the engineering industry. In his address, Dr. Hewlett Johnson appropriately referred to the unparalleled industrial development which this country had witnessed since 1847, and spoke of the vast achievements of mechanical engineering science since the foundation of the Institution. Those achievements, he said, had displayed a spirit of adventure as well as the spirit of invention, and he pleaded that the works of engineers should continue to be dedicated to the well-being of humanity.

Official Opening of Celebrations

On Monday afternoon the members and delegates and their ladies assembled in the Great Hall of the Institution of Civil Engineers for the official opening of the celebrations. The President, Lord Dudley Gordon, was in the chair, and the opening address was delivered by the Lord President of the Council, Mr. Herbert Morrison, who said that he considered it a great privilege to offer the Institution of Mechanical Engineers congratulations upon its centenary, and to extend, on behalf of the Government, a warm welcome to the representatives from kindred bodies overseas. The Institution, like most successful British organisations, had begun in a modest way, but it had steadily grown in stature with the passing years, and at no time in its existence had it been held in greater esteem, both in this country and abroad, than it was to-day. It was indeed fortunate, Mr. Morrison remarked, that during the critical years of the war and during the present difficult time of recovery and reconstruction, the three sister Institutions of Civil Engineers, Mechanical Engineers and Electrical Engineers should be so strong and healthy, and that their affairs should be conducted in such a statesmanlike manner. The harmony existing between those powerful and virile institutions had been of untold value to Government on the many occasions when it had been necessary to seek the advice of the engineering profession.

Mr. Morrison went on to say that in our struggle to win through present difficulties, engineers were among the front line troops. A blue print was merely the conception of the final machine, and blue prints of schemes for increasing exports, for increasing output, and for developing new industries were but plans of campaign. The practical realisation of the plan depended largely on the skill, ability and knowledge of the scientists and designers who committed the ideas originating in the laboratory to the drawing-board, of the craftsmen who translated the conceptions of the designers into prototypes, and of those in the factories—both management and workmen—who turned out the finished products. Progress in mechanical engineering came through the use and development of scientific discovery, largely through the application of fundamental work carried out by physicists and engineering scientists. It was often alleged, Mr. Morrison commented, that while we in Great Britain were pretty good in carrying out fundamental research, we were not so very wideawake in applying its results, and that we often allowed others to reap where we had sown. That, he thought, was a serious matter at the present time, for it would be very distressing if potential customers for our exports got it into their heads that it was no use to look to Great Britain for new and up-to-date products. It was no use talking about developing new ideas if the ideas did not exist; in other words, if for some reason this country did not happen to breed men with the right sort of minds for applying science. National characteristics, however, did not change very quickly, and if we produced great applied scientists and great inventors in the past, we might be sure that we were still capable of producing them, and that there would always be shoulders worthy of wearing the mantles of the giants of the past. In taking the opportunity of the Institution's celebrations to "praise famous men," Mr. Morrison said that it was not because he believed that our achievements were behind us, but because he was certain that what had been done in the past could be done again, and because he believed that there were to-day British engineers whose claim to fame would be equal to that of their great forefathers.

The Lord President then spoke of the Institution's famous Presidents, of the papers that had been presented to it, and of the useful work initiated by its research committees. He referred appreciatively to the work of the Institution's secretary, Dr. H. L. Guy, who had presided over a committee of the Advisory Council of Scientific and Industrial Research to survey the post-war needs for basic research in mechanical engineering science, and who had recently consented to serve as the first Chairman of the new Mechanical Engineering Research Board.

In conclusion, Mr. Morrison said that when we were a rich country, and as a result of overseas investments were able to buy everything we wished to buy abroad, it was only natural that the financial and accounting departments should assume a very prominent part in the control and development of industry, and that we should be inclined to neglect the technical and selling sides. Now that conditions had changed, however,

and we had to rely on what we could produce ourselves and sell to others to keep the nation solvent, we must again turn to our technical men and to our scientists and rely on them to take the lead, as they did when the country's industrial wealth was first built up. It was right and proper that a great body of engineers and scientists should have a feeling of pride in itself and in the very highly skilled vocation which it represented.

The President, Lord Dudley Gordon, after thanking the Lord President for his address, briefly reviewed the more important points in the history of the Institution. He referred to the fact that the membership to-day in all grades of the Institution—including the Automobile Engineering Division—was nearly 28,000. Recalling Mr. Morrison's remark that the celebrations provided an opportunity "to praise famous men," Lord Dudley Gordon said that he would like to add, "let us follow their example."

Sir Robert Robinson, F.R.S., was the next speaker, and he expressed the congratulations of the Royal Society, of which he is the President. Mechanical engineering, he said, was closely dovetailed with other branches of the subject, and there had been the most intimate action and reaction between its progress and that of mathematics and the physical sciences. He thought it was interesting to note that the early developments had been largely in the field of invention, more often than not associated with actual manufacture, and that the increasing application of scientific principles to engineering dated from about the middle of the nineteenth century that was from about the time of the foundation of the Institution. It almost coincided with the end of the belief that heat or caloric was fluid occupying space between the atoms, as shown, for example, in the diagrams drawn by John Dalton. The development of the theory of heat as a mode of motion and of modern thermodynamical concepts had been of immediate importance in mechanical engineering.

Sir Robert then spoke of the work of scientists, particularly that concerned with the materials used by mechanical engineers, after which he touched upon some of the human aspects of the work of engineers. The inestimable services rendered to the community by engineers were, he thought, fully recognised, but whilst some potentiality for uplift might now be conceded to the astronomer, to the theoretical physicist and to some biologists, the engineer seemed to be considered as cold as his refrigerators and as deliberate as his machines. This very superficial estimate, Sir Robert declared, was born of ignorance, for the truth was that the great men who were engineers had been imbued with a passionate zeal for service and with fiery enthusiasm that had alone enabled them to surmount with triumph the most formidable obstacles. Their reward was an almost unique joy of accomplishment, and in some measure all could share their pride. The Institution had notably advanced the professional and technical standards of mechanical engineering for a century, and it had also inculcated the spirit of the pioneers. It was largely on account of the efforts of engineers, collectively and individually, that we had survived the ordeal of two great wars. In recalling the glories of the past, Sir Robert concluded, the members of the Institution were not resting on their oars, but were gaining fresh resolution and encouragement to attack the problems of the future.

The greetings and congratulations of overseas engineers were conveyed, first by Jhr. ir. O. C. A. Van Lidth de Jeude, Vice-President of the Royal Dutch Institute of Engineers, which was founded shortly after the Institution of Mechanical Engineers. He paid special tribute to the mechanical engineers in this country and to their admirable achievements during the war, which had been of benefit to all Europe. The last speaker was Professor A. G. Christie, an hon. member of the Institution and a Past-President of the American Society of Mechanical Engineers. In conveying the greetings of that Society, Professor Christie said that American engineers valued very highly the work that had been accomplished by the Institution and its members.

Centenary Exhibition

On Monday evening there was a reception by the President at the Science Museum, South Kensington, where a special exhibition has been arranged to mark the Institution's centenary. That exhibition will be open to the public until August 24th. The Museum made a particularly happy and appropriate setting for so large a gathering of mechanical engineers from all parts of the world. At the conclusion of the President's reception, Mr. George Tomlinson, Minister of Education, declaring the exhibition open, said that during the last twenty-six years the Institution and the Ministry which he now headed had worked in a partnership that would prove to be one of the most fruitful in history. They had established the National Certificate courses and examinations in mechanical engineering. In 1922 only 1250 students sat for that examination; in 1946 the corresponding number was 12,000. Others had followed where the Institution had led. But it was still true that National Certificates awarded in mechanical engineering exceeded in number all certificates in other subjects taken together. The scheme had benefited thousands of apprentices and given them the opportunity to qualify for Institution membership. It had, too, raised the engineering skill of the country. In reference to the Science Museum in which the reception was being held, he pointed out that its centenary was not far away. It was founded in 1857 and many of the exhibits were drawn from the 1851 Hyde Park Exhibition. The Museum valued no tie higher than that it had with the Institution of Mechanical Engineers. Looking around at the historic engines and other devices exhibited, he could not help reflecting upon the powers conferred upon man by engineers and feeling the sobering thought that man might fail miserably to make good use of them. A special responsibility in leading mankind lay upon those who understood engineering techniques.

The special exhibition that has been arranged covers a century of mechanical engineering, and is divided into several sections, including mechanical plant for power stations, locomotives, automobile, marine and aero-engines, and hydraulic and handling machinery. Important historical objects are shown in their appropriate galleries. Modern exhibits have been gathered together in Gallery 1 and include a large number of scale models, many lent by engineering firms.

The programme of the succeeding meetings and visits followed a similar plan. The mornings were taken up with the presentation of papers and the afternoons filled by visits to engineering works in the neighbourhood of London. On the morning of each day three simultaneous technical sessions took place. On Tuesday, under "Marine Power Plant," papers on "Oil Engines and Steam Engines for Marine Propulsion," by P. L. Jones; "Steam and Gas Turbines for Marine Propulsion," by T. W. F. Brown, Stanley S. Cook and F. W. Gardner, and "Marine Boilers and Marine Auxiliary Machinery," by Major W. Gregson and Harold Hillier, were presented. Under "Aeroplane Propelling Machinery," the papers were "Piston Aero-Engines," by Harry R. Ricardo; "American Aircraft Propulsion Machinery," by Professor King and W. R. Hawthorne; and "Aeroplane Gas Turbines," by Hayne Constant; and in the third section "Machine Tools," by A. H. Lloyd; "Gauging and Metrology," by John E. Sears; and "Industrial Administration," by Sir George Nelson.

The same evening the Clayton Lecture on "The Possibilities of Nuclear Energy for Heat and Power Production," was presented by Professor J. D. Cockcroft. An abstract of this Lecture is printed on another page of this issue. The Lecture was followed by a reception by H.M. Government at Lancaster House, St. James's, where the guests were received by the Lord President of the Council, Mr. Herbert Morrison.

On Wednesday the technical sessions were devoted to "Mechanical Plant for Power Stations" ("Some Aspects of Generating Station Development," by Sir Johnstone Wright; "Mechanical Plant for Power Stations on the Continent of Europe," by A. Meyer); "Handling Machinery" ("Electric Cranes and Hoists," by H. H. Broughton; "The Handling and Storage of Grain and Other Bulk Materials," by J. M. Fleming; "Public Works Contractors' Plant," by V. W. Bone, W. Savage and R. M. Wynne-Edwards); and in the third section "Heating, Ventilation and Air-Conditioning," by Oscar Faber; "American Developments in Air-Conditioning and Refrigeration during the Last Decade," by W. H. Carrier; and "Refrigeration: The Present Position and Trends," by S. F. Dorey.

In the evening there was a dinner-dance at the Dorchester Hotel, a particularly happy affair, at which delegates and members were able to relax and to think and talk of other things than technicalities.

Thursday opened with technical sessions on "Railway Power Plant" ("Railway Power Plant in Great Britain," by O. V. S. Bulleid, F. W. Hawksworth, H. G. Ivatt and A. H. Peppercorn; "Motive Power Trends on European Railways," by L. Armand; and "Railway Power Plant from the United States Point of View," by P. W. Kiefer); "Education and Practical Training of Mechanical Engineers" (papers by Professor H. W. Swift, W. Abbott and K. R. Evans; by Professor A. Rohn; and by R. E. Doherty covering this country, Europe and America respectively); and "Mechanical Engineering in the Process Industries" ("Mechanical Engineering in the Chemical Industry," by Sir F. Ewart Smith, and "A Note on Mechanical Engineering in the Oils and Fats Industry," by H. J. Gough).

In the evening Sir Claude Gibb presented the Parsons Memorial Lecture, entitled "Parsons: The Man and His Work." We hope to print an abstract of this Lecture in an early issue. A portrait of Sir Charles Parsons, presented to the Institution by the directors of C. A. Parsons and Co., Ltd., was unveiled at the Institution by Viscount Hall, First Lord of the Admiralty.

To-day the technical sessions will deal with "Road Motor Vehicles" ("Private Cars," by Maurice Platt; "Present Position and Tendencies in Respect of Public Service Vehicles," by D. M. Sinclair; and "Goods Vehicles," by V. W. Pilkington); "Applied Mechanics" ("Solid Body Mechanics in Relation to Mechanical Engineering," by

Professor Sir Charles Inglis; "Engineering Materials," by R. W. Bailey; and "Fluid Mechanics," by G. A. Hankins and E. F. Relf); and "Hydraulic Machinery" ("Positive Displacement Pumps and Hydraulic Machines," by H. R. Lupton; "Centrifugal and Other Non-Positive Pumps," by R. Pennington; and "Recent Tendencies and Present Position of Hydraulic Machinery: Water Power Plant," by P. W. Seewer, of Switzerland).

To-night the Centenary Celebrations will be wound up at a banquet to the official delegates at the Guildhall. For those unable to attend this function owing to the limited accommodation, there is to be a dance at the Connaught Rooms. So will finish celebrations, upon the organisation of which the Institution, its members and its staff are heartily to be congratulated.

Obituary

ARTHUR MOGG BROWN

MR. ARTHUR MOGG BROWN, who died suddenly at his home, 79A, Hillmorton Road, Rugby, on Thursday, May 29th, at the age of 92, spent several years in the Transvaal, and was well known in this country. He was the son of the late Rev. J. J. Brown, and was born in Leicester in 1855. Soon after his birth, his family removed to Cirencester, where he was educated. He was apprenticed to Tangye's of Birmingham, and was subsequently with Ransomes of Ipswich, and other engineering firms. He was also connected with some of the early developments of water power in Ireland. In 1885 he set out for South Africa with no prospect in view, and was advised, on landing at Durban, to go on to Pietermaritzburg and Johannesburg. In the latter city he found employment as engineer to the Heriot mine, and was thus in South Africa, in the very earliest days of the development of the Transvaal. In those years Johannesburg was not the modern city of to-day, but rather a collection of single-story wood or corrugated iron buildings, with but a few brick buildings. In 1886 the output of gold was only £34,700, although twenty years later it had risen to over £24,000,000 in value. After some years at the Heriot mine, Mr. Brown was put in charge of the Rand Foundry. Later on he did a good deal of work in connection with the installation of new mining machinery in and around Johannesburg. He became a consulting engineer, and eventually went in partnership with a Mr. McKenzie, forming the firm of Brown and McKenzie, which acted as agent for a number of British companies then exporting mining machinery and equipment to the Transvaal. In 1898 he returned to England and for five years he was general manager of William Foster and Co., Ltd., of Lincoln. He was then appointed to Robey and Co., Ltd., of Lincoln, and subsequently he went into partnership with Mr. Veitheardt, of Veitheardt, Ltd., London. At the beginning of 1914 he took up a position with Petters, Ltd., as works manager, at Yeovil, and remained with the firm throughout the 1914–1918 war, becoming a local director of that firm. He retired in 1922. At that time he was only 67 and he undertook the representation of a number of engineering firms, finally retiring from active service at the age of 83. He was a member of the Institution of Mechanical Engineers since 1891. Arthur Brown was a natural engineer, with an inventive mind, and during his long career he took out provisional patents for a variety of mechanical devices which ranged from a knee table to air-screw driven sledges for arctic exploration. Forty years ago he was working on the variable pitch marine propeller and was actively engaged in the early development of the tracklaying track.

Literature

History of the Institution of Mechanical Engineers. By R. H. PARSONS, M.I. Mech. E. Centenary Memorial Volume. Published by the Institution, Storey's Gate, Westminster. 1947.

THE history of technical societies is unlike the history of nations. The ambitions of princes, the intrigues of statesmen, the contests of rival factions throw no shadows over them. They pursue the even tenor of their ways unblackened by internecine war, and the battle of politics does not echo in their halls. Whilst they reflect the progress of the age to which they belong, whilst they contribute in no small measure to it, yet they stand apart from the social struggles that go on around them. Ever helping in the advancement of civilisation, they do not, or have not in the past, sought to impinge upon the devices and practices of politics. They do the duty that lies before them; they investigate, reflect upon, and report the progress of the arts that they are established to serve. It is only within very recent years that they have come to see a new duty, the duty of directing in some degree the forces that are liberated by the works of their members.

Hence the historian of a great technical body like the Institution of Mechanical Engineers, finds himself limited to a record of facts and events, with here and there some reflections on the influence of great personalities and some comment upon the changes that advancing knowledge or new resources have brought about in the course of years. This is the course that Mr. Parsons has followed in this admirable history.

He opens with a short chapter on the background of the Institution which gives us the atmosphere in which the Institution came into being in Birmingham one hundred years ago. In the next he recounts the surprising growth of the young society between the years 1847–66, when it was still, nominally at least, a provincial body. Amongst the events of those days the holding of summer meetings in great industrial centres away from home calls for attention, for in the course of time they led to the exodus from Birmingham to the Metropolis. That step was taken at the very time when the Institution was contemplating the acquisition of headquarters in its birthplace. It was not taken without opposition, but the overwhelming success of a meeting in London in 1873 virtually settled the question, and in 1877 the Institution set up its headquarters in Westminster.

Allusion has been made in our opening sentences to the concentration of Institutions on their own affairs and their non-interference with national matters. But exceptions can be found to that general rule, and one is presented by the activity of the Institution of Mechanical Engineers in pressing the Government to reform, not the patent laws, but the Patent Office and its procedure. That pressure, after several years, brought about the appointment of a Select Committee of the House of Commons to examine the working of the Patent Office. It reported that a larger staff and a proper office were desirable. Thus began reforms and developments that have continued ever since, and have been of inestimable value not alone to mechanical engineers, but to all inventors.

There follow several chapters in which the progress of the Institution up to the present day is recorded and then we come to what may be justly regarded as the most remarkable part of the whole work—a review of the Topics of Discussion between the years 1847 and 1896. This could not have been attempted by anyone lacking great patience, and could not have been achieved by anyone with a less wide knowledge of mechanical engineering practice and science and with a less skilful pen than those of Mr. R. H. Parsons. Year by year he takes us through the outstanding events in the science and practice of mechanical engineering, as reflected in the papers and discussions of the Institution. This is a masterpiece of technical reviewing, remarkable alike for the thoroughness with which it has been done and the conciseness with which the salient facts and hypotheses are presented. Studying it one is filled with regret that Mr. Parsons was arrested by the weight of material and lack of space from carrying the detailed record forward into the present century. As it stands, it is an unequalled survey of a very important period in mechanical engineering. It will not need to be done again, but it may be hoped that in the future some writer of equal skill and knowledge with our present author will take it onward into later years

Little more need be said to commend a volume which does credit alike to the Institution and the author. It is admirably produced with many good illustrations and excellent full-page portraits of the early fathers. Much has been heard during the present week of Centenary celebrations of the history and works of the great Institution, but members will not value the less this permanent record of the birth, growth, and development of a society to which they are proud to belong.

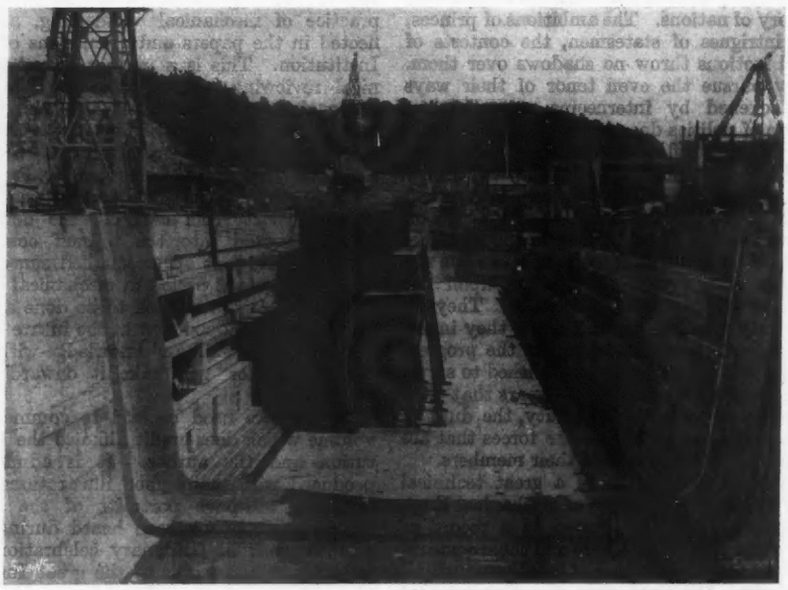
SHORT NOTICES

Spring Design and Calculations. Compiled by J. A. Roberts. Redditch: Herbert Terry and Sons, Ltd. Price 10s. 6d. net.—The author of this book is a member of the research staff of Herbert Terry and Sons, Ltd., the well-known spring makers. Comprehensive and straightforward data on spring design is not always easily available to designers, particularly in view of the wide field of application of this very essential and yet most complex of accessories. The author is an authority on the subject, and has obviously taken a considerable amount of trouble to present in a clear, concise manner the essential factors involved in designing springs of all types. Designers and users of springs will find the contents of this little book of considerable assistance and value in their work.

Locomotive Running Shed Practice. By Harry Webster, B.Sc. London: Oxford University Press. Price 18s. net.—This book deals in a practical manner with the organisation and duties involved in the maintenance and servicing of locomotives in running sheds. In addition to describing all aspects of the work in clear comprehensive language, the author also gives brief details of some of the typical equipment used and its application. The contents are arranged in alphabetical order and are divided into some forty sections, which, wherever necessary, are illustrated by sketches, diagrams, tables or graphs. All who are concerned with this most important branch of railway organisation and working will find the book of both interest and value.

"Princess Elizabeth" Graving Dock, East London, South Africa

IN the accompanying engravings we illustrate the new graving dock at East London, which was formally opened on March 3rd by H.R.H. Princess Elizabeth, and was given her name. The dock has taken nearly five years to complete and can accommodate ships of up to 17,000 tons. It is 723ft long, 102ft 3in wide, and 32ft 6in deep at low water, and was built at a cost of £1,693,000.



GRAVING DOCK AND CAISSON UNDER CONSTRUCTION

Begun during the war years, the Union of South Africa provided the labour, material and plant available locally, whilst the United Kingdom Government supplied material and construction plant which had to be imported. Of the total cost, the Admiralty's contribution in equipment is estimated at £305,000, and in construction plant, £150,000. The agreement was made between the Admiralty and the South African Minister of Transport in 1942, but before starting work on the dock itself, preliminary work had to be done in diverting Gabbanga River. This stream, which has a normal flow of 2 cubic feet per second at flood times, discharges 3000 cubic feet per second. The diversion works necessitated the construction of 420ft of culvert, 575ft of tunnel, and 420ft of open channel. Both culvert and tunnel are 18ft wide and 18ft high, but the open channel is wider and deeper, owing to a steep hillside at the outlet.

Construction of Graving Dock

Work was begun in May, 1943, but many difficulties had to be overcome. The organisation and staff had to be built up at a time when other war work had absorbed nearly all artisans, and the work itself, owing to the congested nature of the area, the necessity of maintaining rail and other facilities and the depth of the works in relation to the surrounding area, was arduous. Excavation was carried out within a sheet pile cofferdam.

On October 12, 1944, pumping was begun, but after some 24 hours the tide was still rising and falling inside the cofferdam, seepage being greater than the pumps could handle. To overcome this seepage manure was shovelled against the seaward side of the piling. Small particles in sinking were drawn into the pile clutches and effectively sealed them. The site was dewatered by October 15th, and seepage was reduced to an amount which was within the capacity of one 4in pump.

By February, 1945, excavation had sufficiently progressed to permit a start to be made with the concrete work and in March of that year a part of the dock floor, about 120ft by 42ft, and 120ft of side wall, had been completed. This portion was required for making a start on the erection of the caisson or dock gate, which is of the floating type, and when fully ballasted weighs 1200 tons. Construction of the caisson is clearly illustrated in the photographs which we reproduce.

The only contract work in connection with the dock itself was the supply and placing of heavy granite stones for the lining of the caisson groove. Concreting was regulated to keep pace with the excavation of the site. There was barely room to fit completed items within the boundary of rail tracks and roadways. Elbow room for construction progress, therefore, did not exist, and for this reason it was not possible to set up a central concrete batching plant. A system of portable mixers from which concrete was conveyed into boxes by chute and "elephants' trunk" was used.

The entire surface of the work is finished with a skin 12in thick of hard concrete.

Excavation of Pump House Site

Excavation of the pump house site proved more difficult than was anticipated. It is situated right over the creek bed, where it empties into the Buffalo River. This area had been filled in 1933 with rubble from the Turning Basin, and it was thought that this material would have settled down through the ooze of the bed and would have filled it from the bottom. Instead, it floated on the ooze, and as excavation pierced the side of the creek, the ooze under pressure squirted out and the surrounding area settled.

It was then realised that a retaining wall would have to be built to prevent the surrounding area, with its railway sidings, from collapsing. Sheet steel piling was driven into the rock and anchored by tie rods to a rock outcrop further back, on one part of the work, and at another part a gravity retaining wall was built by sinking seven 16ft by 16ft concrete caissons to bedrock.

Landing and Repair Quays

Owing to the prevailing westerly winds at East London, a landing quay was considered an essential adjunct to the graving dock. The landing quay is 684ft long with 30ft of water at low tide, and the repair quay is 650ft long, with a dredged depth of 35ft at low water. A vessel to be docked is normally brought alongside the landing quay and then warped into the dock by electric capstans and tugs.

To obtain the required draught a considerable amount of underwater rock had to be broken and removed. For this work two Lobnitz rockbreakers were towed from Cape Town, overhauled and placed in commission towards the end of 1943. By means of these craft a pattern of holes 4ft 6in apart was punched in the area of rock to be removed to a depth of 3ft. The punching tool is a pointed ram of 18in diameter and weighing 16 tons. The resulting rubble was dredged by a bucket dredger. This work is shown in progress in the second photograph reproduced herewith.

A concrete subway encircles the dock and runs the full length of the landing and repair quays. It contains all the services such as electric and telephone cables, and compressed air, salt and fresh water mains, which are tapped at appropriate points. Two 15-ton cranes, one on each side, serve the dock, and one 5-ton crane serves the repair quay. When the whole scheme is completed there will be workshops on the dockside.

QUAY WALLS AND DOCK NEARING COMPLETION

The Tyne Tunnel

On Wednesday of last week, June 4th, Mr. Alfred Barnes, Minister of Transport, formally started the construction of the Tyne tunnel, to link Jarrow and Wallsend by road. The project provides for three separate tunnels under the Tyne, for vehicles, cyclists and pedestrians, and for approach roads linking the tunnels with the main traffic routes on each side of the river. The work which has now been started is on the construction of the two smaller tunnels for pedestrians and cyclists, the driving of the main road tunnel being left for some future date.

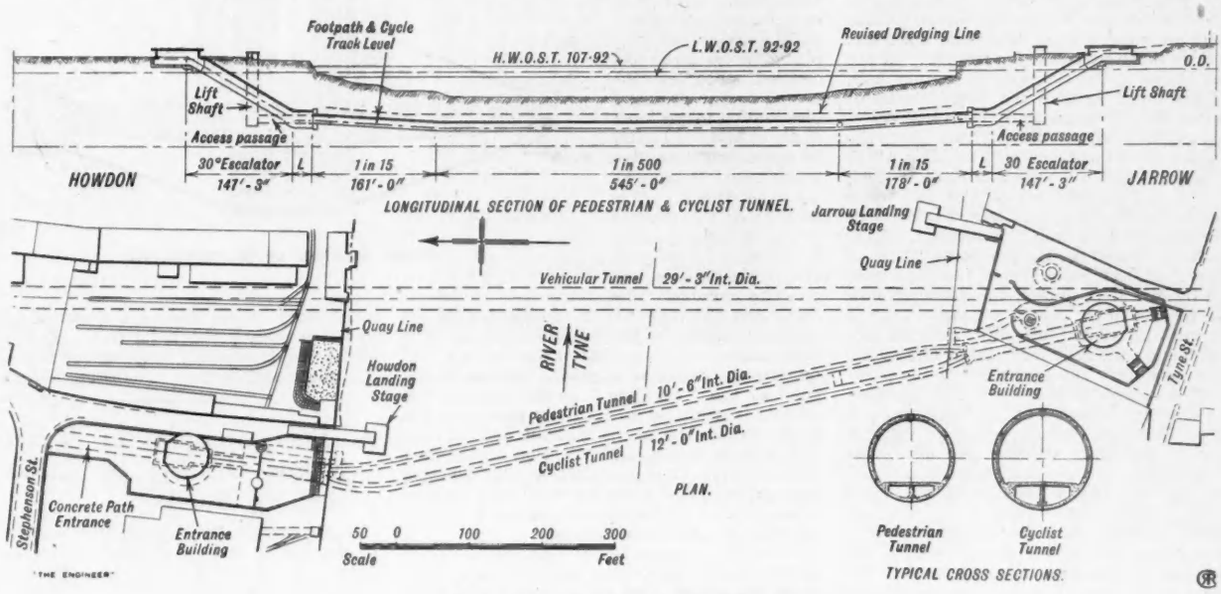
The Tyneside Area

The Tyne tunnel scheme has been under consideration by the Ministry of Transport since 1938. Its object is to improve transport facilities in the industrial areas of the two halves of Tyneside, between Newcastle and the river mouth, a distance of 10 miles. In 1936 the Commissioner for the Special Areas stated in his report that improved facility for crossing the river east of Newcastle was one of the measures needed for the full economic development of the area. The Tyneside area, roughly a rectangle extending 15 miles on each side of the river and 15 miles from the river mouth, had a pre-war population of 1,450,000, of which 1,320,000 were east of the western boundary of Newcastle. The area contains the towns of Gateshead, Newcastle, South Shields, Sunderland, Tynemouth and Wallsend, all having populations exceeding 40,000. Durham lies on the southern fringe of the area, while to the north are Blyth, Morpeth and the Northumbrian coastal resorts. Industries within the area include coalfields, shipyards, engineering shops, steelworks and docks.

At present traffic must use the Shields or Howdon–Jarrow ferries, or enter Newcastle to cross by bridge, for there is no road crossing below Newcastle. Pre-war traffic figures showed that much of the north-bound traffic crossing the Tyne bridge dispersed eastwards along the river bank, whilst south-bound traffic dispersed similarly along the south bank or towards Sunderland. On the Howdon–Jarrow ferry the average daily traffic rose between April, 1937, and April, 1938, when the ferry became toll-free, from 202 to 1546 vehicles. In May, 1940, the averge daily cyclist and pedestrian traffic was 1230 and 6400 respectively.

Particulars of Tyne Tunnel

The arrangement of the Tyne tunnel scheme is shown in the cross-sectional view and plan reproduced below. The first contract, which has now begun, is to complete in about two years a tunnel of 10ft 6in internal diameter for pedestrians and a tunnel of 12ft internal diameter for cyclists, each about 900ft long. A novel provision is the installation of twin escalators at the approaches to each of the tunnels. This will be the first time in this country that escalators have been built for cyclists. Tunnels at Rotterdam and Antwerp have been equipped with escalators for some years and have successfully carried thousands of cyclists and pedestrians, even during peak hours. Experience of the Mersey tunnel has shown that cyclists find difficulty in riding up long inclines at tunnel exits. The separate cycle tunnel at Jarrow will overcome this difficulty and at the same time give safer conditions for cyclists by segregating them from fast vehicular traffic. In addition to the escalators, which will be similar in most respects to those used in the London Underground stations, the Tyne tunnels will be equipped with lifts at each entrance for the aged and infirm.



SECTION AND PLAN OF TYNE TUNNELS

These two tunnels will be lined with cast iron of the same design as that used in the London tube railways, and will be finished with concrete and glazed tiling. They will be well lit and ventilated. As indicated in the plan view, they will be placed side by side with an interconnecting passage for ventilation and pumping arrangements. They will be deep enough to allow the bed of the river to be dredged to a depth of 50ft at low water.

The main vehicular tunnel will carry a 22ft roadway, wide enough for two lines of traffic, and cyclists will not be admitted. Approach roads to the main tunnel will be about 4 miles in length, with dual carriageways, each 22ft wide, two cycle tracks, each 9ft wide, and two footpaths, each 6ft wide. The layout of the approach roads near the entrances to the tunnel is planned to serve a second vehicular tunnel, if ultimately required. It is planned eventually to connect the tunnel approaches with the Great North Road at Seaton Burn, north of Newcastle, and with the Birtley by-pass to the south.

The estimated total cost of the scheme presented to Parliament was £3,600,000, of which the Ministry of Transport is contributing 75 per cent. The work is being undertaken by the Tyne Tunnel Joint Committee of the Durham and Northumberland County Councils. Consulting engineers are Messrs. Mott, Hay and Anderson, and the contractor for the present part of the scheme—the pedestrian and cyclists' tunnel—is Charles Brand and Son, Ltd.

Newcomen Society: Summer Meeting

Some hesitation had occurred before a district, interesting industrially in old times yet accessible and affording accommodation, was decided on for the Summer meeting of the Newcomen Society this year; eventually the choice fell on the Forest of Dean, famous for its iron since Roman times, with headquarters at the George Hotel, Chepstow. Members assembled in the evening of Wednesday, June 4th, and after dinner made a tour of the town, one of the few in England that still retains part of their town walls; these are best seen in the hotel garden. Rastrick's cast iron bridge, 1816, over the Wye, longest span 112ft, and the Castle, dating from the Norman times, were also visited.

The Roman civil town of Caerwent, near Chepstow, was the venue of the first visit on Thursday, under the guidance of Mr. V. E. Nash-Williams, M.A., of the University of Wales, who took part in excavating the site in 1909. His exposition of the *rôle* played by the town during the Roman occupation of Britain was most lucid; time only served to view the town walls, as the principal visit of the day was to the G.W.R. Severn tunnel pumping station at Port Skewitt, by kind permission of Mr. F. W. Hawksworth, M.I. Mech. E., chief mechanical engineer. The party was received by Mr. T. C. Stephens, the station engineer. The main points of interest in the plant are the six Cornish engines made by Harvey and Co., of Hayle, in 1879, 75in cylinders, 10ft stroke, which keep the tunnel drained. Likewise of interest is the Walker fan (1924) for ventilating the tunnel. The value to this country of this tunnel during the war is insufficiently realised.

In the afternoon, at Tintern, some of the party followed up the valley of the Angevy Brook to try to locate the site of the first iron wire-drawing mill by water power, established there in 1587 by the company of the Mineral and Battery Works, under the patent granted to William Humfry and Christopher Shutz in 1565. On this brook, besides several wire mills, a blast-furnace, a spade forge and a paper mill are known to have existed at different periods.

The visit to the ruins of Tintern Abbey by others of the party was marred by rain, but this was offset by seeing the turnery and furniture shops of Messrs. J. Jones and Sons, who gave their permission to do so.

In the evening, the annual dinner, and the toasts of "The King" and "The Immortal Memory of Thomas Newcomen" were followed by an informal discussion on the industries of the locality, led off by Mr. R. Jenkins, the veteran member of the Society, who

submitted an account of the Tintern wire mill.

On Friday, June 6th, the coach first of all crossed Rastrick's bridge, obtaining a good view. In ascending the valley, two charming glimpses of the Wye were afforded. Redbrook Tinplate Works, first established for copper smelting in 1690, was soon reached. The party was received and conducted through the works by Mr. S. Horton, managing director. The works were in full swing and the processes of shearing and rolling down the steel plates into sheets, doubling and redoubling, pickling, tinning, cleaning and packing, were followed with keen interest. Rejoining the coach, a brief visit was paid to Newland Church to see the brass, c. 1600, depicting a Forest of Dean miner, and the monument with stately Latin inscription to John Coster, who refounded the copper industry in England in 1690 at Redbrook. A short run, passing alongside the track of the Monmouth and Coleford tramroad (1810), brought the party, by kind invitation of Mr. W. Teague, to Steam Mills Foundry, Cinderford, where general engineering is carried on. The time there was limited, as lunch was awaiting the party at the Speech House in the seventeenth century hall, where the Court Leet of the Royal Forest of Dean is still held quarterly by the verderers.

Leaving with regret this sylvan spot, the next place visited was the Fancy Colliery, where some ancient chaldron wagons and their track were seen. Parkend, where the last coke furnace in the Forest existed, now the Forestry Commission's School, was next reached. Some of the party visited the Bixlade Stone Works of the Forest of Dean Stone Firms, Ltd., and were shown by Mr. J. C. James, the manager, how blocks of sandstone, got in a nearby quarry, which was also visited, are sawn up with shot and sand and converted for building and monumental purposes. The remainder of the party meanwhile visited the Whitecroft Pin Manufacturing Company's works, by kind invitation of Mr. S. C. Buttfield, director, where an immense variety of pins, hair curlers, gem clips, also light stampings for the electrical trade, are produced by automatic machinery of great ingenuity. The visit concluded by the presentation to each lady in the party of a box of samples of the products of the firm. After tea at Parkend Guest House, the coach journey was resumed *viâ* Lydney. Chepstow was reached in time for dinner, after which those who were not too tired visited I. K. Brunel's railway bridge (1852), over the Wye, the prototype of his better-known bridge at Saltash.

On Saturday, before returning to town, a visit was paid to the Roman military station at Caerleon to see the amphitheatre and the museum.

The visit was voted quite as successful as any that have preceded it, which is saying much.

Fly-Wheel Propulsion

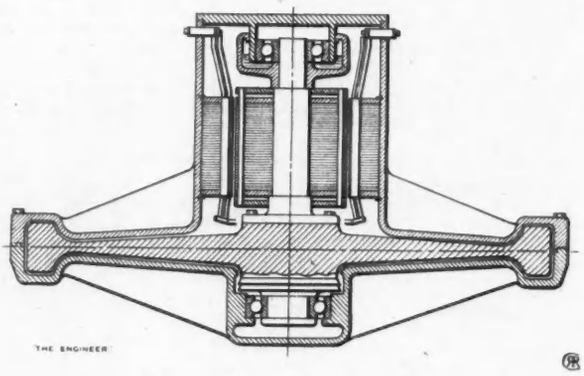
For a number of years Oerlikon, Ltd., Zürich-Oerlikon, Switzerland, has been studying the possibilities of storing electrical energy for transport purposes with the object of developing a system of propulsion that will be independent of overhead conductors and live rails, and will be free from some of the limitations associated with accumulator batteries. This work has produced some interesting results, which were demonstrated during our recent visit to Switzerland, when we were given the opportunity of making a short trip on an experimental vehicle fitted with a novel form of propulsion unit deriving its motive power from the energy stored in a rotating fly-wheel. Before a run this fly-wheel is driven up to a high speed by a direct-coupled motor, after which the connections are changed and the kinetic energy of the fly-wheel is converted into electrical energy, which is fed to the driving motors and used to propel the vehicle.

Briefly, the "Electrogyro" system, as it is called, consists of a fly-wheel of high-tensile strength Cr-Ni steel, which is directly coupled to the rotor of a three-phase machine. The fly-wheel is mounted, with its axis vertical, on heavy ball bearings, and is totally enclosed in a housing which is filled with hydrogen gas, so as to reduce frictional losses. It is claimed that the fly-wheel when running idle will take ten to fifteen hours to slow down from top speed to standstill. As will be seen from the accompanying sectional view, the fly-wheel and the three-phase machine are both housed in a common casing. In the present experimental form, as illustrated in the accompanying engraving, the driving motors are underslung from the front end of the vehicle frame and a chain drive is interposed between the motors and the driving wheels.

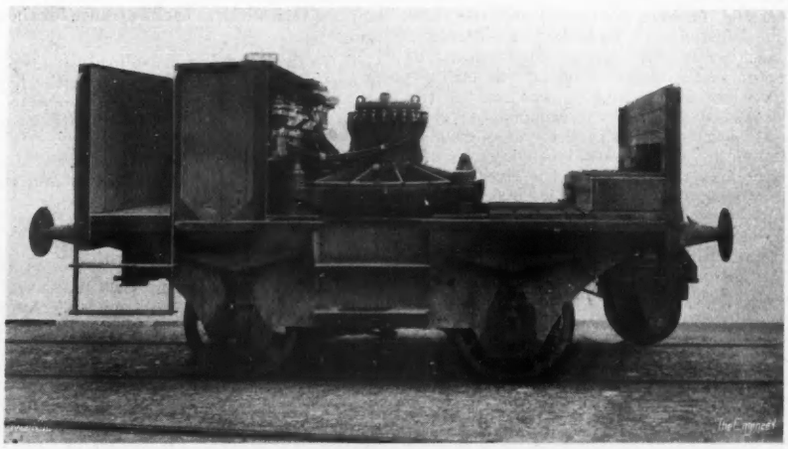
It is arranged that useful tractive effort is obtained from the fly-wheel while it is being slowed down from full speed to approximately half speed. Energy is restored to the fly-wheel at convenient halting places, where the direct-coupled motor is connected to the ordinary distribution mains (normally at 220 to 380 volts, 50 cycles) until the fly-wheel speed is brought up to 3000 r.p.m. It is stated that this process of re-energising the fly-wheel can usually be effected in between one and two minutes. The direct-coupled motor is so designed that its starting current is less than its normal full-load current, which minimises the starting load on the distribution network. The collector gear at the "charging" points and on the vehicle is arranged so that the motor can be connected to the mains without loss of time and without any special attention on the part of the driver. Condensers, whose main function is described below, serve the subsidiary purpose of keeping the power factor between 0·8 and 1 during the "charging" period.

When the vehicle is running the fly-wheel drives the direct-coupled machine as a generator, the stator of which is excited by a bank of capacitors. The generated three-phase output is supplied to the driving motors. A number of synchronous speeds, varying from 6 to 10, can be obtained by pole changing, which, taken in conjunction with the normal speed control of the driving motors, gives a wide and flexible range of control to the whole system, taking into account the demands of vehicular traffic and the slowing down of the fly-wheel.

Theoretical considerations, which have been confirmed by tests, showed that a fly-wheel weighing about 1 ton would be capable of driving a 10-ton railcar a distance of 6 to 10 miles without "recharging." Being experimental, the arrangement of the vehicle illustrated would require some modification to obtain the best results from the technical possibilities of the system. It is claimed, for instance, that this vehicle could accommodate a fly-wheel unit capable of storing twice as much energy as the existing unit. Evidently the practical applications of "Electrogyro" propulsion must be governed largely by economic considerations and local conditions. Generally, on densely loaded traffic routes, one of the orthodox traction methods would probably prove more satisfactory. Nevertheless, for certain specific duties, notably perhaps, for transporting gassy mines, the new system may, under favourable circumstances, offer an interesting alternative.



CROSS SECTION OF ELECTROGYRO



EXPERIMENTAL RAILCAR FITTED WITH ELECTROGYRO

A Development in Traction Motor Gearing on L.P.T.B. Rolling Stock

The present methods of mounting gears and pinions on to the driving axle and armature shaft of underground rolling stock have remained the same for very many years. The pinion, which has a tapered bore, is shrunk on to the armature shaft to ensure concentricity of parts, and relative movement is prevented by means of a straight key with parallel sides.

Experience on the London Passenger Transport Board system has shown the desirability of keeping gears and pinions together throughout their lives. When motored wheels and axles are removed from a vehicle for maintenance, the pinion is removed from the motor and clamped to the wheel and axle assembly until refitted to a car, when the proper pinion is mounted on the motor shaft.

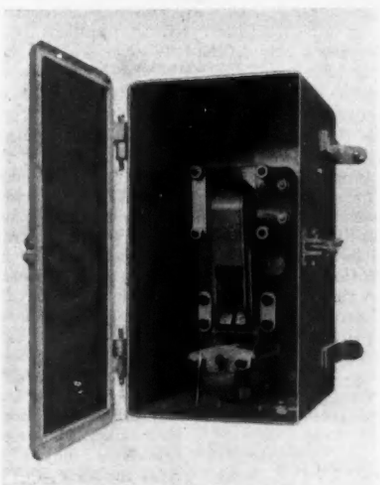
It was considered that if the pinion is

properly fitted to the armature shaft there should be no need for a key; if, however, the pinion was not properly fitted, experience showed that the key did not save considerable damage both to the keyways and the key itself, as well as to the taper seating of the pinion on the shaft. In accordance with this decision, the Board arranged service tests with a number of pinions on which the key fastening was eliminated and reliance for transmission of torque was placed entirely on the shrink fit.

Initially, service tests were conducted on electric shunting locomotives, because of their large amount of low-speed high-torque operation. Experience with these tests established that using shrink fit only was satisfactory as a means of assembly and had advantages over the conventional method. This experience was confirmed in an extensive series of service tests on passenger cars, and it has now been decided that the pinions on the traction motors of the Board's future railway rolling stock shall not be provided with key fastenings.

Compressor Starting Auxiliaries

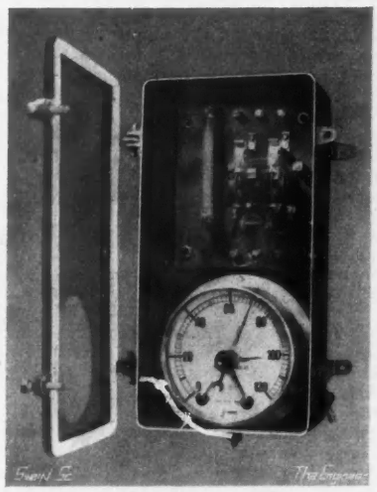
UNLOADED starting of reciprocating compressors, which results in reduced starting torque, can be achieved by the use of a form of electrically operated pilot valve designed and manufactured by Brookhirst Switchgear, Ltd.,



GASTIGHT PILOT VALVE

Chester. This equipment ensures that the compressor is started without load, and that, as soon as the motor attains full speed, load is applied by connecting the compressor to the receiver. Although the pilot valve is suitable for air, its principal uses are for nitrogen, town gas, ammonia, carbon dioxide and for non-corrosive and explosive gases generally, at pressures up to 200 lb per square inch. The pilot valve is designed to prevent any leakage of these gases to atmosphere, but the equipment is not claimed to be flameproof.

As illustrated herewith, the pilot valve is an ironclad, wall-mounted assembly consisting of a clapper type operating magnet and a two-way valve. The valve itself is spring loaded in the "off" position with the valve plunger resting firmly on the lower seating controlling the inlet of gas from the receiver. Of the three pipe connections, shown in the accompanying drawing, the small $\frac{3}{16}$in bore pipe is the exhaust, which is connected to the suction side of the compressor; the central $\frac{5}{16}$in bore pipe is connected to the unloading valve and the right-hand $\frac{5}{16}$in bore pipe is connected to the receiver.



PRESSURE GAUGE AND RELAY PANEL

In operation the motor is started either by hand or by a pressure switch and the valve operating coil is energised at the same time as the stator contactor is closed. A pivoted armature is attracted by the operating coil and a forked extension on the lower portion of the armature moves the valve plunger A against a strong compression spring B. The armature is not rigidly coupled to the valve plunger; a small compression spring C ensures correct seating of the plunger on the upper seat. This movement of the plunger allows gas from the receiver to be admitted to the underside of the unloading valve plunger, which is thereby lifted against the action of weights or springs. This action closes the unloading valve and opens the blow-off valve to which it is mechanically coupled. The closed unloading valve ensures that no gas can enter the cylinder, and the open blow-off valve relieves all pressure from the delivery side of the compressor piston, which is therefore unloaded from the first stroke.

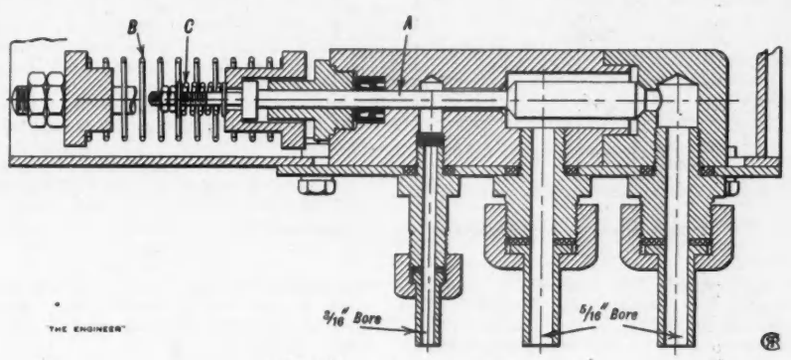
As soon as starting is completed with the compressor running at full speed the pilot valve operating coil is de-energised and the armature is released, allowing the valve plunger to resume its original position under the action of the compression spring. This movement cuts off the receiver pressure from the plunger of the unloading valve. The springs or weights open the unloading valve and close the blow-off valve, allowing the compressor to commence pumping into the receiver.

The pilot valve can readily be incorporated in any of the usual methods for starting the compressor motor. Time-delay relays, where they form part of the star-delta auto-transformer or rotor resistance starters, can also be used for the control of the pilot valve. If the motor is started direct on line a separate time-delay switch or relay must be fitted for operation of the valve.

All the working parts are enclosed in a heavy gauge dust-proof sheet steel case measuring 14½in by 10½in by 11½in, with a hinged cast iron door fitted with gaskets at all joints. Cable entry for the supply to the operating coil is at the top of the case, a blank flange being fitted for drilling to suit various cabling requirements. The equipment is suitable for a.c. operating voltages up to 440V at 50 cycles per second.

Another piece of auxiliary equipment that has been developed by the same firm is a pressure-actuated relay panel for starting and stopping a compressor. In the form illustrated herewith this device consists of a pressure gauge fitted with "start" and "stop" contacts, which can be set to any desired values of pressure to control a small relay. The relay control circuit is so arranged that wear on the pressure gauge contacts is reduced to negligible proportions. The heavy-duty operating contacts of the relay are connected to the motor starter, which is thereby subjected to control by the preset values of pressure applied to the gauge. Adjusting knobs are provided on the pressure gauge dial so that the start and stop contacts can be set to the required values.

The pressure gauge and the relay panel above it are housed in a sheet steel dustproof case arranged for wall mounting. A hinged pressed steel door with a glazed circular opening over the gauge dial forms a cover for the front of the case. The relay panel is suitable for a.c. voltages up to 440V, 50 cycles per second, and the relay contacts can handle a maximum current of 10A.

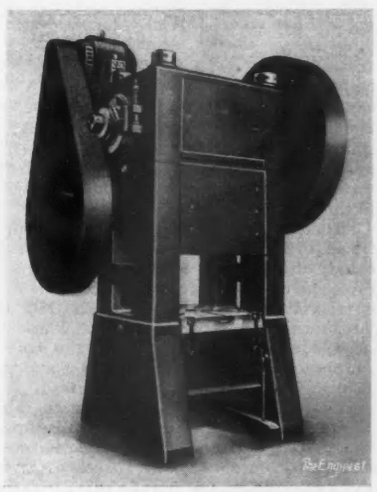


PILOT VALVE IN SECTION

A 125-Ton Double-Sided Press

THE photograph we reproduce below shows a new double-sided power press now being made by F. J. Edwards, Ltd., London, N.W.1. It is of the single-geared type and has all the moving parts enclosed by steel plate guards.

The cast iron bed has a 30in by 38in, tee-slotted, detachable bolster, with a 10½in diameter hole carrying a loose centre ring with a 5in diameter hole. The bridge, column and bed are heavily cross keyed and held by four massive steel tie rods shrunk into place.



125-TON PRESS

A forged steel crankshaft is driven through a treadle-operated multi-jaw clutch, and is fitted with a safety pawl which prevents it from rotating in the reverse direction whilst the machine is at rest. The trip mechanism of the clutch incorporates a means for setting the machine for single non-repeat or continuous ram action. When the machine is set for continuous working, the ram gives 35 strokes per minute.

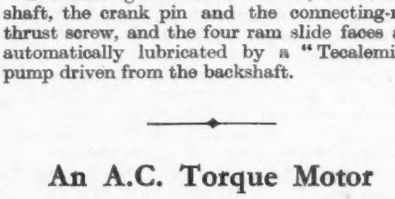
The ram has a face 24in by 28in, with a 3in diameter tool hole, and moves between four machined guide faces. Two of the guides are fitted with easily adjusted gibs for taking up wear. It has a stroke of 6in and exerts a pressure of 125 tons ½in from the bottom of the stroke. The length of ram adjustment is 4in, and with the stroke down and the adjustment up there is a clear distance of 18in between the ram face and the bed.

The bearings of the backshaft, the crankshaft, the crank pin and the connecting-rod thrust screw, and the four ram slide faces are automatically lubricated by a "Tecalemit" pump driven from the backshaft.

An A.C. Torque Motor

In its latest form the torque motor manufactured by Scophony, Ltd., Wells, Somerset, embodies the same basic principles as its predecessor, the type BTM torque motor in which a gyrating member takes the place of the conventional rotor. Whereas the earlier version required a d.c. source for polarising the gyrating member, the construction has been so modified that the new motor operates from an a.c. supply at a higher voltage.

Referring to the accompanying illustration, the a.c. torque motor consists essentially of an Alnico steel permanent magnet A, which is magnetised axially so as to produce a d.c.



TORQUE MOTOR

magnetic flux. As shown in the drawing, the path of this flux is along the steel shell B, through the laminated stator C, into the gyrator D, which thereby becomes polarised, and through the steel plate E.

One end of the ferrous gyrator or armature D is fixed to a diaphragm F of steel or rubber, so that, although the armature cannot rotate, its free end can gyrate. The stator C is of 4-pole construction, each pair of poles 180 deg. apart, forming a separate phase. Phase displaced currents are supplied to the coils of each phase, which alternately attract and repel the polarised armature and constrain it to describe a conical gyratory motion about the end that is supported by the diaphragm. The gyratory movement of the armature D is translated into a rotary movement of the output shaft J through the medium of gearing. This gearing consists of a gear wheel G mounted rigidly on the end of the armature and meshing with an internally cut gear H, which is pinned to the output shaft and rotates with it in plain bearings K. The wheel G has 99 teeth and can gyrate only in an orbit limited by tooth contact with the gear H, which has 100 teeth. Since each gyration of the wheel G produces one tooth advancement of the gear H, the overall ratio of the system is 100 : 1.

It is arranged that the amplitude of gyration is very slightly greater than the depth of tooth engagement and, with the special tooth form adopted, an arc of contact of 240 deg. is obtained. Because several teeth are in engagement simultaneously the gear is capable of transmitting considerable power for its size, and as the clearance on the disengaged side is made smaller than the working depth of gear tooth the gear cannot fall out of step with the gyrator. Since the gyrator moves synchronously with the applied phase-displaced current, the output shaft rotates exactly in step with the supply frequency.

The frequency of the supply can vary from 1 cycle to 300 cycles per second, so that using a 100/1 reduction the output shaft will rotate synchronously from 0·6 r.p.m. to 180 r.p.m., the speed being 36 r.p.m. at 50 cycles per second. To operate the motor from a single-phase supply of constant frequency, one phase must be excited directly while the second phase is fed through the necessary condenser, causing the current to lead by approximately 90 deg. electrically, thus producing a rotating field.

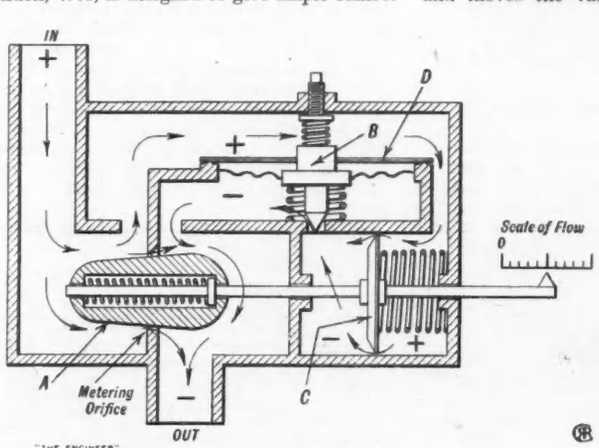
The direction of rotation of the output shaft can be altered readily by switching the phase sequence of the stator coils.

For operation on 230V, 50 cycles, single-phase a.c. supply the torque motor requires a 1 microfarad phase-splitting condenser, and the input is less than 20VA. The torque is above 450 gm cm (6 ounce inches), but because the motor has no facilities for cooling, its rating at 230V is intermittent.

It can readily be seen that a system of this kind has considerable scope as an actuator in remote control systems, integrating devices, &c, because the starting and stopping characteristics of a gyrator with low inertia can be made very uniform, so that any number of these actuators fed from the same alternating source will move in unison. An important advantage of the Scophony torque motor is that its high torque is fully maintained up to the instant of switching.

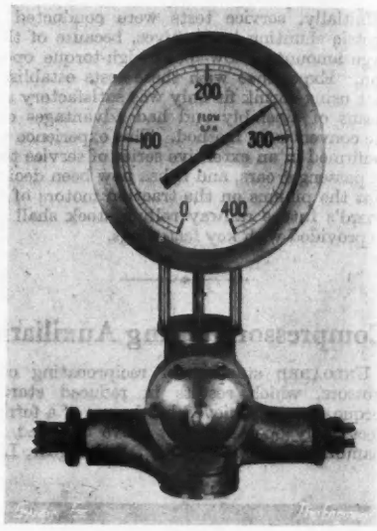
A Flowmeter

A FLOWMETER unit which has been developed by Negretti and Zambra, 122, Regent Street, London, W.1, is designed to give ample control for the operation of indicating, recording, controlling or transmitting devices. The design and mechanism of this new unit can be seen in the diagram and the photograph we reproduce herewith.



DIAGRAMMATIC ARRANGEMENT OF FLOWMETER

In the unit a tapered plug A is arranged concentrically within a sharp-edged orifice in the body so as to maintain a constant predetermined pressure difference in the flow across it. The rate of flow is then proportional to the orifice area, which, again, is proportional to the movement of the plug. A small proportion of the flow, which is constant under steady conditions, by-passes the metering orifice and is used to provide power to position the plug. Plug movement is effected in order to maintain the predetermined pressure difference across the orifice. The plug is moved by the action of the fluid in an adjustable diaphragm operated needle valve B. This valve regulates the by-passed flow through the annular clearance



FLOWMETER

between a sharp-edged disc or piston C, on the rod of the plug A, and the parallel cylinder in which it is situated.

It will be seen that movement of the needle of the valve B in respect to its seating creates a pressure difference across the piston. Resultant movement of the piston is transmitted to the plug, which takes up a new position to restore the pressure difference across the metering orifice to its predetermined value. In order to compensate for variations in temperature of the liquid, and the resultant change in density or viscosity, a spring of bi-metal strip D is coupled to the diaphragm valve. This spring reacts to temperature changes and moves the valve accordingly to modify the controlled pressure difference across the metering orifice. For a particular fluid the valve can be designed to render measurements independent of temperature either if the flow is required in units of mass or of volume.

A spring in the tapered plug allows it to slide along its rod if the pressure difference rises above a predetermined value, and also serves to prevent damage should the rod become jammed.

The shape of the tapered plug can be varied to give different types of scales—uniformly graduated; with open graduations in the lower portion of the scale and closing towards the top; close graduations in the lower portion of the scale and opening towards the top; or with close graduations opening from the centre of the scale and closing again towards the top, so as to provide an open scale reading over any particular region of the scale.

B.O.A.C. Route Mileage—The British Overseas Airways Corporation's gross route mileage over twenty-seven routes is now 103,782¼ miles.

Continental Engineering News

Poniatowski Bridge, Warsaw

THERE was inaugurated recently by the President of the Polish Republic the restored Poniatowski bridge over the Vistula River. It replaces an old structure blown up by the Germans in 1944. Four spans of that bridge were heavily damaged and two piers entirely destroyed. Designed by Professor S. Hempel, the structural system of the new bridge is composed of a series of two hinged arches. Tubular columns, resting on the arch ribs, carry longitudinal girders. In turn, these girders support the decking composed of sheet steel vaults, welded to girders and filled with concrete. Each span of the restored bridge is composed of seven arch ribs, formed of five to seven sections, according to the span length, and weighing between 6 and 8 tons. Four spans have been entirely rebuilt. They have lengths of 191ft, 227ft, 227ft and 267ft. The arch ribs of the bridge are strengthened by means of vertical stiffeners, assembled by welding. The new bridge is about 35 per cent lighter than the old one. The weight of steel per foot run is 2·3 tons, instead of 3·6 tons for the pre-war structure. The total length of the Poniatowski bridge is 1650ft.

Svinesund Bridge

A new link between Sweden and Norway has been added to those already existing in that part of Europe. The link referred to is the bridge across the Firth of Svinesund in the southern border district. The new bridge has a length of 1378ft, with a central span over the F rth of 509ft. The rise of the arch is 131ft 3in, and the total height above water 214ft. Concrete was used for the main span, while for eight overland approach arches Swedish granite was chosen. The arch is of cellular box construction, and the decking accommodates a roadway 23ft wide and two footpaths, 4ft wide each. Approach viaducts on each side of the main arch are divided into six spans on the Swedish side and two on the Norwegian side, each span having a length of about 80ft. On account of the steep slopes of the shores and the great height of the bridge roadway above the water level, together with the absence of any approach roads during the period of building, extensive arrangements had to be made for the transport of materials. The contractors, Messrs. Armerad Betong A.B., of Malmö, Sweden, placed 2600 cubic yards of concrete and 20,000 tons of hewn granite. The Svinesund bridge has been built to the order of the Swedish Highway Board at a cost of 3,400,000 Swedish crowns (about £200,000).

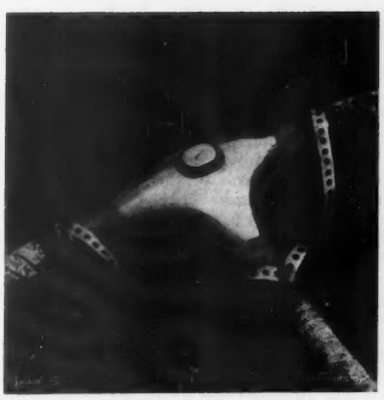
Dnieprostroi Dam

Rebuilding of the large Dnieprostroi dam, in Russia, destroyed during the Second World War, is proceeding rapidly. Since the beginning of the rehabilitation works, 260,000 cubic yards of wrecked concrete have been removed and 4000 tons of structural steelwork dismantled. Technical services in charge of the restorotion of the dam have already placed 70,000 cubic yards of concrete and laid 40 miles of new railway tracks. Repair work at the power station at present under water will be done inside a cofferdam, built of stone and sand. Turbines for the hydro-electric power station will be partly constructed in U.S.S.R. and partly in U.S.A. It is reported that the output of the new turbines will be considerably higher than that of the pre-war plant.

Pressed Copper Service Boxes

SERVICE boxes of pressed copper were introduced and are being manufactured by B.I. Callender's Cables, Ltd., Norfolk House, Norfolk Street, London, W.C.2, at a time when lead, the familiar raw material for service boxes, is in short supply. The copper service box, as an accessory for electrical mains installations, possesses a number of advantages in its own right so that it can be regarded as an alternative to rather than a substitute for the conventional lead box. Because of its mechanical strength, the copper box is able to withstand the normal rough treatment experienced in handling and in transit. Its lightness is an advantage in storage and in transit.

The box is designed to provide generous jointing room and is made in two halves, each of which is accurately formed by pressing from hot tinned copper sheet, $\frac{1}{32}$in thick. Both halves are flanged; the flanges on the lower half are lipped to locate the plain flange of the upper half. During assembly the lips are closed down on the upper flange, gripping it firmly in position ready for plumbing. Compound filling is effected through a flanged hole centrally placed in the upper half. The hole and its cap are made oval so that the cap cannot rotate during the subsequent wiping operation. At each cable entry the copper sheet is scored axially and can readily be opened to form "fingers," which can be adjusted and dressed down to fit the cable sheath ready for plumbing. A study of the accompanying engraving, in conjunction with the short description given above,



PRESSED COPPER SERVICE BOX

indicates that the use of these pressed copper boxes should present no unusual problems to jointers who are accustomed to handling the established design of service box.

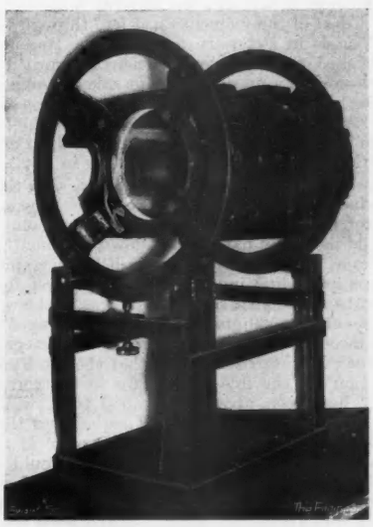
Primarily, the copper boxes were designed to be installed in cast iron protection boxes. The copper service boxes are, however, sufficiently robust to admit the feasibility of improvised methods of protection against mechanical damage and corrosion in many instances where it is possible to dispense with cast iron protection boxes. In such situations cover tiles can be placed above and beneath the service box with bricks laid round the sides to form an enclosure that is ready for filling with compound. Our illustration shows a pressed copper service box bonded and ready to be enclosed in improvised protection of the kind described.

A range of eight service boxes is manufactured to cater for the usual sizes of main and branch cables. Flexibility in accommodating various cable sizes is further enhanced by the special design of cable entry described above. To give them greater strength the larger boxes are ribbed. There is an appropriate size of protection box for each of the eight service boxes.

Stripping Traction Motor Cases

UNLESS special tackle is available for handling traction motors in repair sheds, the task of dismantling and reassembling the motor cases can be tedious and time-wasting. Since the poles and interpoles are fixed to the case by bolts which are accessible from the outside, it follows that, if the work is being done on the normal stripping bench, one set of main pole bolts is covered while the adjacent interpoles are difficult to get at. Consequently the motor case must be tilted, either by crowbars and wedges or by an overhead crane. Both methods are unsatisfactory; the first is haphazard and clumsy, while the second is, at best, wasteful. Both methods are open to the further objection that the motor cases are usually unsymmetrical and can easily be tilted too far even by an experienced workman.

To overcome these difficulties and to facilitate the work of dismantling and reassembling motor cases, a simple form of ring-frame stand has been developed and brought into use in London Transport's Acton works. Designed specifically to accommodate the "L.T. 100" motor cases, the stand consists essentially of a



RING STAND FOR TRACTION MOTOR CASES

ring frame resting on rollers which are carried on an angle iron base, as illustrated herewith.

At its open end, which can be seen in the accompanying engraving, the motor case is bolted through the existing bolt holes in the end cover to four cranked lugs projecting radially inwards from a 3ft ring. The commutator end of the motor case is partially closed. A second ring supports this end of the motor case, which rests on a chordial bar and is bolted by means of a lug to the ring itself. This method of suspension leaves the commutator end of the motor case projecting through the ring and overhanging the base, making the brush leads easily accessible. The two rings, with the motor supported between them, form a rigid assembly.

The base is a simple welded angle iron structure, 2ft 6in high, carrying a roller at each corner. Each ring rests on a pair of these rollers and the assembly consisting of motor and rings can easily be rotated by hand so that every part of the motor case is made readily accessible. One pair of rollers is grooved to locate the corresponding ring longitudinally. In earlier designs all four rollers were grooved, but to allow for slight variations in the distance between the rings a certain amount of play had to be allowed. By grooving only one pair of rollers in the later designs any variation in the ring spacing is taken up by the smooth rollers, allowing the grooved rollers to be machined to a tighter fit on the ring. To fix the case in any position a friction lock is fitted to the base. The Ferodo-lined friction shoe bears on one of the rings, pressure being applied by a screw and hand wheel.

ELECTRICITY RATIONING IN SWEDEN.—The Swedish Government Fuel Commission has announced that rationing of electricity seems unavoidable, owing to the serious water supply situation in the country's lakes and rivers, combined with the scarcity of coal and the growing industrial demand for electric power. As a first step in the efforts to save power, it is stated that the use of electric heating stoves is to be prohibited. There will also be considerable restrictions on display window and publicity illumination. The allotment of electric energy to private households is expected to be controlled in the same way as the rationing of gas, which was in force until quite recently, *i.e.*, each household having its allotment fixed according to its normal consumption.

Industrial and Labour Notes

Industrial Production

Surveying this country's economic situation at a Press conference on Wednesday of last week, the Lord President of the Council, Mr. Herbert Morrison, said that industry had regathered in the months of April and May a good deal of the momentum it lost through the fuel crisis in February and March. Recently published figures indicated that in April 100 civil aircraft were delivered for sale and export—the highest monthly figure since the war—and the April output of locomotives was higher than in the two preceding months. Wagon production, however, was disappointing in April.

Talking about steel, Mr. Morrison said that production in the first two weeks of May was better than in April, but the Whitsun holiday would naturally have pulled down the monthly average. Lack of steel was still handicapping the shipbuilding industry, as in the first four months of the year shipbuilding was at the rate of about 800,000 gross tons a year, as against the target of 1,250,000 gross tons. With regard to coal, Mr. Morrison stated that the total production for the five months up to the end of May had been about 83,000,000 tons, which indicated that we should get rather less than 100,000,000 tons in the first half year. If the coal target was to be reached, there would be at least 100,000,000 tons to be produced in the second half year, when, of course, loss of output from holidays would occur. At the same time, there were now about 24,000 more miners in effective employment than a year ago, and it looked as if the intention to increase the manpower to 730,000 by the end of the year would be achieved ahead of schedule.

After a brief reference to exports, Mr. Morrison emphasised that there were a few valuable weeks before the height of the holiday period in which a drop in production would become inevitable. He thought that if in the next six weeks the work of the past two months could be kept up and improved upon, this country would not only get back to the level of output ruling prior to the fuel crisis, but would also make up what had been lost.

On Friday last Mr. Morrison met the chairmen of the Regional Boards for Industry, together with their district committees for a further discussion on the production drive. An official statement says that Mr. Morrison spoke on the future development of the production drive in the regions by means of conferences, films and factory talks. More production conferences, representing managements and workers, are to be arranged throughout the country.

Trade Disputes

There were 207 industrial disputes, involving stoppages of work, reported to the Ministry of Labour as beginning in the month of April, and 18 stoppages which had begun earlier were still in progress at some time during that month. In these 225 stoppages, there were approximately 61,200 workers involved, including those thrown out of work in establishments where the disputes occurred, and the aggregate number of working days lost is estimated to have been about 235,000. In the month of March there were 190 stoppages of work, involving 53,200 people, and causing a loss of 113,000 working days. In April, 1946, 213 stoppages of work occurred through disputes, involving 42,100 people, and leading to an aggregate loss of 157,000 working days.

In its May issue *The Ministry of Labour Gazette* has published some detailed information about the strikes which occurred in 1946. There were altogether 2219 stoppages of work through disputes during the year, 14 of which had begun in the closing days of 1945. The aggregate number of workers involved in these stoppages was about 530,000, approximately 120,000 of whom were indirectly involved. The aggregate number of working days lost in 1946 at the establishments where the stoppages occurred was 2,182,000, compared with rather more than 2,800,000 working days lost through disputes in 1945.

Although the coal-mining industry accounted for three-fifths of all the stoppages of work in 1946, and for about two-fifths of all the workers involved, most of the stoppages in that industry were of short duration. The metal, engineering and shipbuilding industries accounted for about one-half of the aggregate number of working days lost through stoppages in 1946. An analysis of the principal causes of the disputes which led to stoppages of work last year shows that wage questions accounted for more than two-fifths of the stoppages and of the total number of workers directly involved. Stoppages connected with working arrangements—other than wages and hours of labour—and with the employment of particular classes or persons together accounted for nearly one-half of the total number of stoppages and nearly two-fifths of the workers directly involved.

Nationalisation

Speaking at the recent annual meeting of William Beardmore and Co., Ltd., Sir James Lithgow, the chairman, said that nationalisation had not produced cheaper, better and more abundant fuel, as many of its chief advocates claimed that it would. On the contrary, it seemed necessary now to reconcile ourselves to dearer, poorer and scarcer supplies with all that that implied in a lowering of our industrial tempo and an ultimate reduction of our national wealth. Even greater loss to the country's industrial prosperity, Sir James commented, must inevitably follow the handing over to centralised political control of such a highly technical and diversified industry as that of iron and steel.

Referring more specifically to the fuel shortage, Sir James said that the failure of the Ministry of Fuel and Power to obtain from the individual miner an output at least approaching what he was accustomed to give to his individual employer had made itself even more manifest. Attempts were now being made, he suggested, to obscure the issue by including opencast workings in reports of output but not in manpower figures, and by suggesting the necessity for recruitment of a far larger personnel than had been ever before employed in mining coal for our home consumption.

Industry and Employment in Scotland

A White Paper which surveys industry and employment in Scotland was published for the Scottish Office last week by H.M. Stationery Office (price 2s.). It is additional to the Economic Survey for 1947, as it presents detailed facts concerning Scotland's industrial situation.

Although more insured workers were in employment in the development areas of Scotland in July, 1946, than in 1939, there has been a sharp increase in unemployment from 20,000 at the end of the war to 94,000 in February, 1947. At the same time, it is observed, the latter figure is far below the 1939 unemployment level of 172,000. Some of Scotland's basic industries, such as coal-mining, foundries and agriculture, are short of skilled men and men fit for heavy work, but the White Paper shows that there are considerable problems of unemployment amongst men not suitable for those industries but fully suitable for others. By the end of February, 1947, thirty-five firms had been allocated space in twenty-eight Government factories in Scotland, and it was expected that these would provide employment for 20,000 people.

Dealing with coal production, the White Paper estimates that Scotland's share of the British target of 200,000,000 tons in 1947 would be over 24,000,000 tons, and it is suggested that ultimately Scotland's coal output must reach 30,000,000 tons a year. Manpower for the coal mines has already increased from 79,100 in 1946 to 80,000. On the subject of iron and steel, it is indicated that the steel industry's plan is to raise steel production from its present annual rate of 1,820,000 ingot tons to 2,200,000 tons. Considerable progress has already been made in building up the labour force of the Scottish iron and steel industry, though there are still about 1000 vacancies. Improvements in conditions, mechanisation of foundries, and the training of unskilled workers for skilled jobs are, it is stated, some of the measures being taken.

Industrial Negotiating Machinery

The Association of Supervisory Staffs, Executives and Technicians held its annual conference at Brighton last week-end, and in the course of his Presidential Address Mr. J. H. Williams urged that there should be a drastic overhaul of existing industrial negotiating machinery. He said that unofficial strikes were justly condemned, but to condemn them was not enough. Workers were not always led by irresponsible people, and too frequently the cause of unofficial strikes could be traced to frustration.

Mr. Williams admitted that it was farcical to join a trade union, elect officers and then act contrary to their advice, but he thought it must be acknowledged that the delay occasioned through antiquated, cumbersome negotiating machinery was often responsible. Much of the negotiating machinery operating to-day lent itself, in Mr. Williams's view, to procrastination, and whilst he said that he would be the first to condemn unofficial strikes, there were circumstances where unconstitutional methods might well be the only weapon left with which to secure justice.

Mr. Williams also commented on joint consultation in all aspects of industrial life, saying that any enlightened management that had nothing to hide would not hesitate to introduce the workers into the mysteries of the balance sheet and show how production was related to wages, sales, profits and reserves.

The Industrial Organisation Bill

The Industrial Organisation Bill was read a third time and passed in the House of Commons last week, after several amendments had been discussed. In moving the third reading, the President of the Board of Trade, Sir Stafford Cripps, explained that the Bill had arisen very largely out of the recommendations made by a number of working parties on the methods which should be adopted for the development and organisation of the various industries into which they had been making inquiry. It laid down a procedure whereby, subject to the future consent of Parliament, councils could be set up for various industries, with largely advisory functions, and composed of representatives of both sides of industry, together with such independent persons as were thought desirable in any particular case.

The object, Sir Stafford said, was to get one responsible body which could speak for all interests in the industry concerned, and which, in its considerations of the interests of the industry, would have in mind as well the interests of the nation and of the consumers of the industry's products. It was the Government's intention to give great weight to the recommendations of such bodies when they were set up, and to use them in a large degree for that liaison with industry which was now such an essential part of any national planning.

Speaking for the Opposition, Mr. Oliver Lyttelton expressed the hope that the Bill would be administered in a way which would be helpful, and which would, as far as possible, release individual genius and enterprise. He hoped also that private enterprise industries would not become further victims to increasing bureaucracy.

French Engineering News

(From our French Correspondent)

PARIS, June 6, 1947.

Labour in the Saar has posed an important problem for the military government. In 1939, workers numbered 247,025 and there was no unemployment. In 1946 the figure had dropped to 165,200, of which 102,905 were employed in industry. In spite of the return of 7000 prisoners of war, about 60,000 more men are needed. Since the French occupation of the Saar wages have remained stationary, but the Mines Service is now studying new rates and a complete reorganisation of social insurance.

* * *

French automobile constructors are seriously concerned over the scarcity of lead for the manufacture of accumulators, as the quantity available in the past quarter is insufficient to maintain production of vehicles. It is probable that a large number of vehicles will have to be delivered without batteries, or else the output of vehicles will have to be reduced. At Peugeot's works production is now 110 vehicles per day, consisting of 2-tonners, of which 20 per cent are exported, light lorries, of which 50 per cent exported, and the "202" model car, of which about 85 per cent are for export. With its 9000 hands, and its equipment reconstructed and overhauled for mass production, the Peugeot Company hoped to reach in 1947 its 1939 output, which was 300 vehicles daily. Raw material supplies will decide whether the target can be reached.

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The various French shipyards are active. The Messageries Maritime have in hand the building of four cargo vessels of 4200 tons, one of which will be used for the transport of wines. These ships will be built in prefabricated sections, and it is thus hoped that completion time will be materially reduced. The "De Grasse," now at the Penhoet yards, enters into the Havre to New York service in July. At present the North Atlantic route is only worked by the "Oregon," "Wisconsin" (17,000 tons) and the "Indochinois" (14,000 tons). The "Liberté" (52,000 tons) goes to Saint Nazaire in September for dry docking. Recently at the Trait shipyards the tanker "La Mayenne," the second of a series of three destined for the Navy, was launched. Construction, begun in 1939, was interrupted frequently by bombardments. She has a displacement of 6135 tons, is 380ft in length and has a beam of 50ft. This type of vessel is propelled by turbine twin screws and develops 5700 h.p., with a speed of 14 knots. At the Graville yards, Havre, there were recently launched a fire-fighting boat for the port of Dunkirk, and at the Augustin Normand shipyard the light steamer "Elpenor."

Work restarted normally the day after a strike in the Peugeot and Suchaux workshops. The strikers, composed of teams employed in the maintenance of the machine shops, obtained agreement to a bonus. Four hundred hands only joined in the movement, but about 2400 stopped work for several hours, their machines having been stopped by the maintenance strikers. Discussions are continuing on wages and premium pay generally.

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The nationalised gas industry is to spend 1000 million francs, or about 2 million pounds, on the construction of sixty horizontal retorts at the Cornillion plant, which belonged to the Paris Gas Company before nationalisation. The work will last 2¼ years and construction of the first fifteen retorts has already been started. At present equipment amounts to fifty retorts, of which five are too old for use. The remaining retorts are divided between four gasworks. Several retorts were damaged by air bombardment during the war. The new retorts to be constructed in the great Cornillion plant at St. Denis will produce 575,000 cubic metres of gas daily, or 155 million cubic metres per year, of 4500 calories. Monthly coal consumption will amount to 365,000 tons. The new retorts are expected to effect considerable saving in labour.

Notes and Memoranda

Rail and Road

THE MERSEY TUNNEL.—According to the *Manchester Guardian*, a new traffic record for the Mersey Tunnel was created during May, when 484,181 vehicles, carrying 578,205 passengers, passed through it—an increase of 115,000 vehicles and 177,000 passengers on the figures of the previous May. To speed up traffic, it has been decided to close the branch tunnels during the busiest morning and evening periods and so permit continuous traffic.

ROLLING STOCK FOR EUROPE.—Several further consignments of locomotives and rolling stock are being shipped this week by U.N.R.R.A. from Liverpool to Yugoslavia. They include ten shunting locomotives, bought from American military surplus stores; four workshops, each comprising six 20ft starboard gauge bore wagons, bought from ex-military surpluses in the United Kingdom, of American manufacture, and fitted with British workshop equipment; and four bogie well wagons, each of 80-ton carrying capacity. Other rolling stock provided by U.N.R.R.A. to European countries includes: sixty-five Liberation locomotives of British make for Yugoslavia; thirty for Poland, and fifteen for Czechoslovakia. The shipment of 1900 new 20-ton capacity railway wagons of British make has now been completed. Czechoslovakia receiving 903; Poland 745, and Greece 252. U.N.R.R.A. is also supplying to various countries 54,000 tons of railway bridging, of which 26,000 tons have been obtained from British military surplus stores. The balance comes from new production, and the total comprises over 1000 spans. So far about 20,000 tons have been shipped, and the rest is in process of shipment, most of it is for China, but other consignments are for Greece and Czechoslovakia. U.N.R.R.A. has also bought from British ex-military stocks and of British make approximately 20,000 tons of Bailey bridging for despatch to Czechoslovakia, China, Yugoslavia, Albania and Greece. Watercraft, bought from military surplus stores in the Mediterranean area, number thirty-seven, of which Albania has received ten, Greece twenty-three and Yugoslavia four. The approximate cost of all these supplies is £7,250,000.

Air and Water

B.O.A.C. SERVICES.—During the past month, the British Overseas Airways Corporation has introduced three new services and increased the frequency of a fourth. Two of the new services are to the Persian Gulf and India and are operated by flying boats. The third new service is from London Airport to Lydda, Palestine, and is operated by Dakota aircraft. The service which has been increased in frequency is that to New York, a trans-Atlantic Speedbird now arriving at and departing from London Airport every day of the week.

P.L.A. DREDGING PROGRAMME.—The Port of London Authority's dredging programme for the current year provides for the removal of approximately 3,000,000 tons of mud and silt from the Thames and the docks of the Port of London. Of this total, 1,812,000 tons will be dredged from the river channel between Limehouse and Broadness, a distance of twenty-one miles. The remainder of the work includes dock dredging, ranging from 3000 tons, or three days' work, in the West India Import Dock, to 300,000 tons, about fifteen weeks' work, in the Tilbury Dock Basin.

CIVIL AIRCRAFT RESEARCH COMMITTEE.—A written Parliamentary reply made last week by the Minister of Supply, on behalf of the Ministry of Civil Aviation, sets out the terms of reference of the Civil Aircraft Research Committee of the Aeronautical Research Council. They are to consider the basic research problems arising from the evolution and operation of civil aircraft, having regard amongst other matters to the probable requirements of the operators; to recommend periodically to the Council programmes of research; and to report to the Aeronautical Research Council. Professor A. A. Hall is chairman of the committee, the other members of which are Professor A. R. Collar, Dr. T. E. Easterfield, Professor S. Goldstein, Major F. M. Green, Sir Melville Jones, Professor R. L. Lickley, Dr. H. R. Ricardo, Mr. P. A. Sheppard, Professor G. Temple, and representatives of the Ministry of Supply, the Ministry of Civil Aviation, the National Physical Laboratory, and the three Airways Corporations.

Miscellanea

"ENTERPRISE SCOTLAND."—An exhibition entitled "Enterprise Scotland," is to open at the Royal Scottish Museum, Edinburgh, on August 25th. It is being arranged by the Scottish Committee of Industrial Design, which works in close co-operation with the Council of Industrial Design, and the aim of the exhibition is to bring together examples of all that is best in Scottish design and manufacture. The exhibition will be divided into four parts illustrating tradition and ancient crafts, country affairs, various phases of modern Scottish industrial and cultural life, and the future planning of industrial estates and community centres. An important feature of the exhibition will be to reveal the progress Scotland is making in the establishment of the lighter industries.

BUILDING EXHIBITION, 1947.—The Building Exhibition is to be held at Olympia, London, from November 19th to December 4th, this year, after an interval of nine years. Ninety-five per cent of the stand space is already booked, the exhibitors including firms long associated with this exhibition and concerned with every kind of material, method and mechanical aid in building, civil engineering and contracting. In addition to individual exhibits there will be displays by the Ministry of Labour, Ministry of Fuel and Power and the Department of Scientific and Industrial Research. The Architectural Association is to have a stand of its own design to mark this year's centenary of the Association. The chairman of the exhibition is Sir Lancelot Keay, President of the Royal Institute of British Architects.

THE B.B.C. TELEVISION SERVICE.—Plans to enlarge considerably the present television service in this country are indicated by the announcement that Marconi's Wireless Telegraph Company, Ltd., are to supply the sound transmitter for the new Birmingham television station in addition to another complete installation of both sound and vision transmitters in the near future on a site not yet decided by the B.B.C. Many technical improvements based on wartime experience and research carried out in the development of radar, are being incorporated into the design of the new vision transmitters. Wider bandwidth circuits—a direct development of radar technique—with other special features, will give greatly increased fidelity of reception. Special air-cooled transmitting valves have been designed and developed for the new installation. All the controls of the transmitters will be mounted on a central control desk and a special room at the transmitting station will contain monitoring and testing equipment to enable B.B.C. engineers to check the quality of the transmitted signals.

ANDREW CARNEGIE RESEARCH FUND.—In 1901 Mr. Andrew Carnegie put at the disposal of the council of the Iron and Steel Institute a sum of money, subsequently increased to 100,000 dollars, to form a fund from which research grants could be made. The council is prepared to award one or two Andrew Carnegie Travelling Scholarships each year, the value of which will depend on the circumstances of each case. They will normally be of the order of £500, but smaller or substantially greater sums may be given. The scholarships will usually be tenable for one year and are intended to assist recipients to conduct research outside their own countries. Awards will also be made of Carnegie Research Grants tenable in the recipient's own country. The amount of any one grant will not exceed £250 in a year and the normal range is from £50 to £200. A condition governing these awards is that candidates must be under 35 years of age, but there is no restriction on sex or nationality. The Carnegie Scholarships and Grants are intended to enable investigators to conduct researches into the metallurgy of iron and steel. The scheme is not intended to facilitate ordinary collegiate studies, but proposals for post-graduate research and work for higher degrees as well as applications for grants in aid of investigations will be considered, and the council is prepared to take a wide view of the terms of reference. The results of the research are to be communicated to the Iron and Steel Institute in the form of a report for publication. An Andrew Carnegie Gold or Silver Medal may be awarded to the author of the report which in the opinion of the council is the most meritorious of the year. Grants will normally be paid in four quarterly instalments, the first on award, the second and third on receipt of satisfactory brief progress reports, and the final instalment on receipt of the completed report.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Institute of British Foundrymen

Tuesday to Friday, June 17th to 20th.—Annual Conference in Nottingham.

Institute of Economic Engineering

To-day, June 13th.—Cowdray Hall, W.1. "Research and Expansion in Industry," R. Cecil Smart. 7 p.m.

Institute of Physics

Friday and Saturday, July 18th and 19th.—INDUSTRIAL RADIOLOGY GROUP: Electric Lamp Manufacturers' Association, 2, Savoy Hill, W.C.2. A Symposium on "Methods of Crack Detection."

Institute of Welding

Wednesday, June 25th.—Grosvenor House, Park Lane, W.1. Annual dinner. 7.15 p.m.

Institution of Civil Engineers

Wednesday, June 25th.—N. WESTERN ASSOCIATION: Visit to open-cast coal sites in the Wigan area. 2.30 p.m.

Thursday and Friday, July 3rd and 4th.—NEWCASTLE-ON-TYNE ASSOCIATION: Summer meeting in Newcastle-on-Tyne.

Friday, July 4th.—BIRMINGHAM ASSOCIATION: Visit to Avonmouth Docks. 8.45 a.m.

Institution of Electrical Engineers

Saturday, June 21st.—S. MIDLAND CENTRE.—Visit to Meaford power station. 12.30 p.m.

Saturday, July 26th.—N. MIDLAND STUDENTS: Summer Outing. 9 a.m.

Institution of Mechanical Engineers

Sunday to Friday, June 8th to 13th.—Centenary celebrations in London (see page 399, May 9th).

Institution of Mining and Metallurgy

Thursday, June 19th.—Geological Society, Burlington House, Piccadilly, W.1. "Lead-Zinc Mineralisation in North Derbyshire." G. A. Schnellmann and J. D. Willson; and "Wartime Treatment of the Lead-Zinc Dumps situated at Nenthead, Cumberland." E. W. O. Dawson. 5 p.m.

Institution of Mining Engineers

Wednesday to Friday, June 18th to 20th.—Summer meeting in Edinburgh.

Iron and Steel Institute

Wednesday and Thursday, June 18th and 19th.—Inst. of Civil Engineers, Great George Street, S.W.1. Symposium on Powder Metallurgy. 2.15 p.m. Wednesday and 10 a.m. Thursday.

Thursday, June 26th.—4, Grosvenor Gardens, S.W.1. "The Effect of Different Methods of Pretreating Iron and Steel before Painting." F. Fancutt; and "The Protection of Iron and Steel by Metallic Coatings," J. C. Hudson and T. A. Banfield. 2.30 p.m.

North Western Fuel Luncheon Club

Wednesday, June 18th.—Engineer's Club, Albert Square, Manchester. "National Fuel Service—Is there a Plan?" Sir Ernest Smith. 12.30 p.m.

Public Works Congress and Exhibition

Monday, July 21st, to Saturday, July 26th.—London, Olympia.

Stephenson Locomotive Society

Saturday, June 28th.—Visits to Brighton works, Redhill and Brighton running sheds, Southern Railway.

Friday, July 4th.—Visit to Swindon Works, G.W.R.

Women's Engineering Society

Saturday, June 14th.—Visit to the City and Guilds College, Exhibition Road, S.W.7. 2.30 p.m.

Contracts

SIMON-CARVES, LTD., has received a contract, valued at over £1,000,000, to build for Guest, Keen and Baldwins, Ltd., a coke oven and by-product plant, at Margam, South Wales. The contract includes coke-handling plant, primary and secondary coke screening plant, a 2000-ton self-emptying coal bunker, a system of conveyor loading for the charging lorry, and also a complete by-product recovery plant.

DORMAN LONG (AFRICA), LTD., a subsidiary of Dorman Long and Co., Ltd., Middlesbrough, has been appointed main contractor for the structural design and execution of the whole of the steel buildings and structures in the new South African Steelworks at Vanderbijl Park, Vereeniging, Transvaal. The contract comprises at least 45,000 tons of structural steelwork, to a value exceeding £3,000,000. The company will co-ordinate the whole work and sublet to other South African structural firms such portion of the work of fabrication as will ensure completion at the earliest date before the end of 1949.

Personal and Business

MR. N. A. HUNT has been elected a director of Scammell Lorries, Ltd.

DR. P. DUNSHEATH, M.I.E.E., has been elected an honorary member of the Engineering Institute of Canada.

MR. A. RAMSAY MOON is resigning his position as Director of the British Welding Research Association.

WILLIAM JONES, LTD., has moved into new offices at 21, Russell Square, London, W.C.1 (Telephone, Museum 2911).

MR. M. B. U. DEWAR and LIEUT.-COLONEL R. M. GREG have been elected directors of the Neckar Water Softener Company, Ltd.

W. T. HENLEY'S TELEGRAPH WORKS COMPANY, LTD., has acquired an extensive site at Newtown, Co. Durham, for the erection of a new cable factory.

MR. C. DAVIES has been elected president of the Institution of British Agricultural Engineers. Mr. F. E. Rowland and Mr. Alexander Hay have been elected vice-presidents.

A. A. MOFFAT AND SONS, 39, Cheapside, E.C.2, have been appointed agents in London and Southern England for John Ackworthie, Ltd., machine tool makers of Birmingham.

MR. K. P. JAMES, M.I.Mech.E., and Mr. W. A. Smythe, M.I.Mech.E., have been appointed production engineers in the Chief Mechanical Engineer's Department, London and North Eastern Railway.

W. T. HENLEY'S TELEGRAPH WORKS COMPANY, LTD., announces that the address of its Liverpool Branch has been changed to Empire Buildings, Fazakerley Street, Liverpool, 3 (Telephone, Liverpool Central 4066).

MR. R. H. STEPHENSON has been elected chairman of the Dry Dock Owners' and Repairers' Central Council. Mr. G. S. Cromar has been elected senior vice-chairman, and Mr. E. L. Champness, junior vice-chairman.

MR. J. WOOLMAN has been elected to the Council of the Production Engineering Research Association of Great Britain. Mr. F. H. Rolt, M.I.Mech.E., has been nominated by the D.S.I.R. to serve on the Association's research committee.

LONDON TRANSPORT announces the following appointments: Mr. C. E. Dunton, M.Inst.C.E., Civil Engineer (Development) in the Chief Engineer's Department, and Mr. K. Brinsmead, M.Inst.C.E., M.I.Mech.E., Acting Permanent Way Engineer (Railways).

SIR CHARLES NEWTON has retired from the position of chief general manager of the London and North Eastern Railway Company, and has resigned from the Railway Executive Committee. Mr. Miles Beevor, who has succeeded Sir Charles as chief general manager of the L.N.E.R., has been appointed to the Railway Executive Committee.

Reports on German and Japanese Industry

Limited numbers of copies of the reports of Intelligence Objectives Sub-Committees on German and Japanese Industry listed below can be obtained from H.M. Stationery Office at the prices stated.

No. of report.	Title.	Post free. s.	d.
F.I.A.T.:			
610	Dimensioning of Directional Antennas	3	8
792	Iron Cores: Manufacture of Low Hysteresis Iron and Iron-Nickel Powder Cores	1	7
808	Contribution to the Regeneration of Pickling Solutions	1	1
869	A New Method of Beneficiation of Low-Grade Iron Ore by the Wiedelmann Washing Tower	1	1
917	Manufacture of 2-Ethyl-Anthraquinone at the I.G. Farbenindustrie Plant in Ludwigshafen	1	7
925	Formamide Production at the I.C. Farbenindustrie Plant at Oppau	1	1
C.I.O.S.:			
XXXI–47	Research Laboratory, Deutsche Edelstahlwerke A.G. Krefeld: Properties of Steels; Alloy Economy, &c.	1	7
B.I.O.S.:			
561	The Manufacture of Sodium Sulphide at I.G. Farben Fabrik, Wolfen	1	7
602 (Appendix)	Lay-Out of Plywood Factories: Interrogation of Dr. Ernest Doffine	1	1
701	The German Asbestos Textile, Jointing and Friction Lining Industries	3	2
706	Metal Powders (Sintered)	13	4
788 (Appendix)	The German Vitreous Enamel Industry	1	7
801	German Photo-Engraving Industry: Collodion Emulsion, Crossline Screens	2	7
833	Investigation of German Commercial Explosives Industry	8	3
838	Investigation of Certain German Paper and Board Mills, with Particular Reference to the Production of Leatherboard, Carton and Shoe Board and Coated Papers	3	8
872	German Carpet Industry	5	2
874	Computing and Testing Methods in the German Optical Industry	3	8
880	Sodium Hydrosulphite, Rongalit, and Liquid Sulphur Dioxide Manufacture at I.G. Ludwigshaven: Interrogation of Herr Johannsen	1	7
883	Notes on Casting and Fabrication of Lead and Production of Bahnmetall	2	8
887	Spray Drying, Fatty Acid Distillation, Sodium Perborate at Henkel et Cie., Dusseldörf, Germany	2	8
912	German Sole Leather Tanneries	6	8
914	Manufacture of Light Castings (Baths, Cookers, &c.), in Germany	12	4
923	ZF Electro-Magnetic Gearbox, Type 6 EV-18, for Medium-Powered Cars	1	7
943	"Time and Motion Study" Investigation of German Radio and Associated Industries	10	10
946	The Organisation of the Siemens-Schuckert Turbine Works	3	2
955	German Hatters Fur Industry	2	8
958	Utility of a Klingeinberg Worm Grinding Machine	2	1
960	German Dyestuffs and Dyestuffs Intermediates: Anthrasols, Heliogens, Sirius Light Blue Dyestuffs	8	3
976	Electro-Thermic Production of Aluminium-Silicon Alloys at Lurgi - Thermic G.m.b.H., Horrem	1	1
978	Manufacture of Formaldehyde: Interrogation of Drs. Johannes Casper and Rudolph Stroh (I.G. Leverkusen) and Dr. Ernst Baerwind (Degussa)	1	7
992	Asbestos-Consuming Industries in Germany	4	2
994	German Electrical Industry: F.H.P. Motors, Motor Control Gear, Domestic Appliances, Domestic Refrigerators	6	8
995	Hot-Dipping and Electro-Deposition of Tin and Tin Alloys in Germany	4	2
1001	Manufacture of Chlorinated Polyvinyl Chloride: Bitterfeld	4	8
1002	German Cutlery Industry (excluding Safety Razor Blades)	5	8
1003	Some Aspects of Copper, Nickel and Cobalt Production in Germany	3	2
229	Wrought Light Alloy Plants in Southern Germany	6	2
298	Regenerative Type Heat Exchanger: A.V.A. Gottingen	1	1
514	German Textile Industry	6	2
873	By-product Ammonia Recovery	1	7
875	Phthalic Anhydride Plant as I.G. Farbenindustrie A.G. Uerdingen, Germany	1	1
890	German Methods of Forging and Machining H.E. and A.P. Shell	5	2
929	Monochloracetic Acid and Medicinal Chloroform: I.G. Heochst and Gersthofen	1	7
933	Paper Pulp and Board Moulding Industry in Germany	3	2
937	Dr. F. Raschig, G.m.b.H., Ludwigshafen am Rhein: Tar Products	1	1
939	I.G. Farbenindustrie, Leverkusen: Manufacture of Synthetic Phenol, Resorcinol, Pure Anthracene and Pure Carbazole	2	8
953	Corrosion - Preventing Coatings of Buna S-Ebonite: Interrogation of Dr. Roelig, of I.G. Farbenindustrie, Leverkusen	1	7
957	Developments in Rheolaveur through Washing in Belgium: Coal Washing	3	8
966	German Rubber Footwear and Various General Rubber Goods Plants	5	8
997	German Alloy Steel and Tool Steel Plants	1	7
1000	Potash Recovery and Bromine Manufacture: Preussag Kaliwerke, Stassfurt	1	7
1005	Some German Plants for the Manufacture of Potato and Cereal Starches	3	8

B.I.O.S. Information Section, 37, Bryanston Square, W.1, which has at its disposal a considerable volume of information not in a form suitable for general reproduction, is prepared to receive enquiries regarding all problems relating to scientific and technical intelligence on both German and Japanese industry.

A Seven-Day Journal

New Signalling Lamp for the Merchant Navy

THE Ministry of Transport announces that signalling lamps carried on British merchant ships will in future be electric daylight lamps, of not less than 60,000 candle-power, giving a range of 5 miles on a normal bright day in home waters. After a date to be fixed, these lamps will replace oil lamps as the approved type to be carried by ships of over 150 gross tons making international voyages. The oil lamps at present carried are based on a specification introduced during the 1914–18 war, but they are of little use for daylight signalling, and they cannot be sighted on their object. The specification for the new lamp provides, amongst other things, that the apparatus shall consist of a boxed signalling lamp and a boxed battery, which together shall not weigh more than 38 lb and shall be readily transportable by one man. The illumination is to be by enclosed filament electric bulb, of which two spares are to be provided, and the life of the bulb must be not less than fifty hours when run at the voltage given by the battery after 15 min. of discharge. Provision must be made also for the mounting of an easily removable shade to reduce the axial candle-power to between 8 and 15, which should give a signalling range of 1 mile at night under clear moonlight conditions. A sighting device is to be incorporated in the new lamp so that the beam can be directed on to the receiving station. These signalling lamps will be similar to that developed by the Royal Navy, and used extensively during the recent war by the Merchant Navy. Manufacturers wishing to produce the lamps will be required to meet the conditions of the specification which has been approved by the Minister of Transport, and will also be required to submit specimen lamps to the National Physical Laboratory for testing.

The Institute of British Foundrymen

THE forty-fourth annual conference of the Institute of British Foundrymen opened at Nottingham on Tuesday last and concludes to-day (Friday). At the annual general meeting on Wednesday morning, Mr. P. H. Wilson, M.I. Mech. E., deputy managing director of the Stanton Ironworks Company, Ltd., was elected President, and Mr. R. B. Templeton, of the Ealing Park Foundry Company, Ltd., and Mr. N. P. Newman, of Newman, Hender and Co., Ltd., were elected Vice-Presidents. In his Presidential Address, Mr. Wilson said that, however unpalatable it might be, we had to face the fact that new labour would not be attracted to the foundry industry unless working conditions were improved to such an extent that the margin of difference between the foundry worker and the workers in the lighter industries was appreciably reduced. The foundry industry, which dated back over a very long period, was at a disadvantage compared with newer industries from the point of view both of the age of some of its buildings and because extensions had been made on a piecemeal basis. To-day was a difficult time to undertake a programme of rebuilding, Mr. Wilson continued, but he thought much could be done to improve existing buildings by way of more adequate lighting and ventilation and the elimination of obnoxious fumes and dust, all of which would have the immediate effect of providing cleaner and healthier working conditions. Turning to consideration of machinery equipment and lay-out, Mr. Wilson observed that, in common with other sections of the basic industries, the foundries had not yet regained the standard of productivity per man employed which existed prior to the war. To achieve that, and indeed to improve upon the 1939 standard of productivity, the aim should be a complete elimination of all physical operations which could be satisfactorily and economically performed by mechanical aids. During the war period much valuable work had been achieved in new factories by designing or adapting the plant in such a manner as to bring within the physical scope of female labour work normally allocated to men, and Mr. Wilson thought it would be regrettable if the experience so gained was lost to industry.

Northern Ireland Electricity Development

PROPOSALS regarding future electricity development in Northern Ireland are made in a White Paper which was presented to Parliament at the end of last week by the Minister of Commerce. Electricity distribution in Belfast and Londonderry is in the hands of municipal undertakings, and the view is expressed in the White Paper that the immediate requirements of co-ordination of distribution can be met by bringing the remainder of the country within the supply area of the Electricity Board for Northern Ireland. It is proposed that the generating stations owned by the Government should be transferred to the Board, which would be suitably expanded as to personnel to deal with its increased responsibilities including the implementation of proposals for rural electrification. Referring specifically to the Londonderry undertaking, the White Paper says that the Government is prepared to leave future electrical development there in the hands of the Corporation. The White Paper then goes on to outline a Government proposal that the primary responsibility for co-ordinating electricity generation should be entrusted to a Joint Electricity Committee with statutory powers, and it is suggested that the committee should consist of a chairman to be appointed by the Minister of Commerce, the Belfast city electrical engineer, and the chief engineer of the Electricity Board. The committee's functions would be to direct the day-to-day operation of the generating stations owned by Belfast and the Board in so far as the quantity and rate of output and allocation of load are concerned; to frame generation development schemes to be submitted for the approval of the Ministry of Commerce; to pool for distribution purposes all the current generated at the stations named and to sell energy to the distributing authorities; to arrange with the Eire Electricity Supply Board for the purchase, sale or exchange of supplies of energy should this prove desirable; and to determine what proportion of the annual cost of main transmission lines should be included in the joint cost of production. Commenting on the provision made for reference of generation schemes to the Ministry of Commerce, the White Paper says that the Minister should be in a position to "fortify himself with the advice of some technical authority analogous to the Electricity Commission in Great Britain," and recommends a panel of, say, three eminent electrical engineers to be appointed by the Minister on the advice of the President of the Institution of Electrical Engineers.

Coal to Oil Fuel Conversion

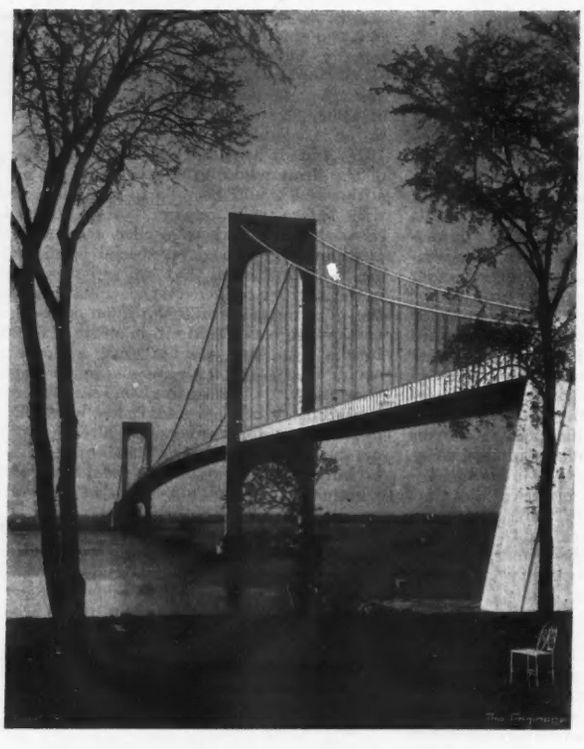
REPLYING to a question in Parliament on Thursday, June 12th, the Minister of Fuel and Power, Mr. Shinwell, made a statement regarding coal to oil fuel conversion. He recalled a prior statement in which it was explained that the annual rate of oil consumption represented by schemes of conversion already approved would be increased to 5,000,000 tons a year, equivalent to an annual saving of coal of 8,000,000 tons, by the middle of 1948. This programme, which was the maximum that could be achieved in that time, had been reviewed, Mr. Shinwell said, and the Government had decided against any further general extension of it for the time being. The matter would, however, be considered again in the Autumn when the trend of coal output would be more clearly established. In the meantime, in order to provide in appropriate cases for applications that were now awaiting consideration, arrangements would be made to import another 1,000,000 tons of oil a year. After meeting those cases, there would be some margin for special cases where it could be shown that the amount of coal saved would be exceptionally high in proportion to the amount of oil burnt, but no other new applications could be entertained. The additional import of 1,000,000 tons of oil a year would not begin to be available before the third quarter of 1948, but it was not anticipated that most of the firms whose applications might now be authorised would be able to complete conversion before that quarter. Any exceptional cases, however, where earlier conversion was possible would be given special consideration. Mr. Shinwell added that unless it was decided in the Autumn to increase the whole programme, the consumption of fuel oil on coal-oil conversion projects would attain a rate of 6,000,000 tons a year, and would result in an annual saving of 10,000,000 tons of coal by the calendar year 1949. Commenting on the statement, the Ministry of Fuel and Power says that the applications for conversions already received are being examined and that applicants will be informed individually as quickly as possible whether or not an allocation of fuel oil can be made. Should other industrial coal consumers, whose coal saving if their plants were converted to fuel oil would be exceptionally high in proportion to the amount of oil burnt, desire to convert, they should make written application to Regional Offices of the Ministry.

Royal Aeronautical Society's New President

DR. H. ROXBEE COX, Director of the National Gas Turbine Establishment, has been elected President of the Royal Aeronautical Society, and will take office on October 1st. He was born in 1902, and after obtaining first-class honours in engineering, took an advanced course in aeronautics at the Imperial College of Science and Technology. In 1924 Dr. Roxbee Cox joined the staff of the Royal Airship Works, and it is of interest to recall that in 1928 he was awarded the Royal Aeronautical Society's "R.38" Memorial Prize for his paper on "The External Loads on an Airship Structure." When the Government decided to discontinue airship work, Dr. Roxbee Cox went to the Royal Aircraft Establishment, where he was able to resume work which he had begun on wing flutter, aircraft structures and aerodynamics. In 1936 he became head of the Air Defence Department of the Establishment, and two years later was appointed chief technical officer to the Air Registration Board. On the outbreak of war in 1939 Dr. Roxbee Cox was seconded as Superintendent of Scientific Research at the Royal Aircraft Establishment, and in 1940 he became Deputy Director of Scientific Research in the Air Ministry, paying special attention to jet propulsion gas turbines. Subsequently, at the Ministry of Aircraft Production, as Director of Special Products, he was closely associated with all British gas turbine work. In 1944 Dr. Roxbee Cox took up an appointment as chairman and managing director of Power Jets (Research and Development), Ltd., which later on became the National Gas Turbine Establishment. Dr. Roxbee Cox is a Fellow of the Royal Aeronautical Society, a Fellow of the Institute of Aeronautical Sciences, a member of the Aeronautical Research Council, and is on the board of governors of the College of Aeronautics. He is the author of numerous papers on various technical aspects of aeronautics, among them being the Wilbur Wright Memorial Lecture of the Royal Aeronautical Society in 1940 on "Civil Aviation," and the Wright Brothers Memorial Lecture of the Institute of the Aeronautical Sciences in 1945 on "Gas Turbines."

Stiffening the Bronx-Whitestone Bridge

THE Bronx-Whitestone bridge, in New York City, recently underwent changes which will make that East River crossing equal to meeting the increased demands that have developed since it was opened to traffic in April of 1939. The bridge was fully described in THE ENGINEER of June 28, 1939. The Bronx-Whitestone bridge has a centre span 2300ft long, and each side span is 735ft long. Including the anchorages, the bridge has a total length of 4015ft. The approach viaducts are 1620ft and 2360ft in length, respectively. The towers, to the top of the cable housings, have a height of 377ft above mean high water. Each of the two cables has a finished diameter of approximately 22in and a sectional net area of 297 square inches. The bridge has a maximum clearance of 150ft at the centre of the span, and a clearance of 135ft at mean high water above the channel, which is close to the western or Bronx shore of the river.



THE BRONX-WHITESTONE BRIDGE BEFORE WIDENING AND STIFFENING THE SPAN

The crossing was built under the Triborough Bridge Authority as a supplementary structure to the Triborough bridge System, with a full knowledge that the new structure, although 5½ miles farther eastward on the East River, might become competitive with the original undertaking because of the likelihood of its drawing much traffic that otherwise would have to use the Triborough bridges to reach sections of New York State and neighbouring Connecticut lying farther northward.

In the years that have followed, traffic over the Bronx-Whitestone bridge has increased notably despite the restrictive effects of World War II and a much curtailed supply of petrol. Traffic also increased over the Triborough bridge, and, inasmuch as the Bronx-Whitestone bridge and the Triborough bridge are conjointly the property of the Triborough Bridge Authority, the cumulative gains have been to the advantage of the Authority by furnishing revenue which must provide for operation, upkeep, betterments, and amortising.

It may be of interest to engineers to know that the Triborough Bridge Authority, at the time of its creation, was an organisation called into being under the laws of the State of New York. It is a public-benefit corporation, empowered with a dual responsibility. It is administered by men in public service; it has the right to issue bonds, and with their issuance comes authority to pay interest on them and to amortise them; but the Authority has no other income to draw upon for maintenance, betterment, and operation than the returns yielded by successfully operating its properties. Therefore, the properties must be so managed and kept up as to make a continuous appeal to public patronage.

In the case of the Bronx-Whitestone bridge bonds in the amount of 18,000,000 dollars were sold in 1937; and up to April 29, 1939—the date the bridge was opened—there had been spent 17,785,000 dollars for real estate, interest on bonds, and construction. The latter item, including overhead, engineering and contingency reserve, called for 15,219,000 dollars.

Mr. O. H. Ammann, M.Am.Soc.C.E., was at the time chief engineer of the Triborough Bridge Authority, and primarily responsible for the design of that structure, athough aided by a number of consultants, eminent in the same technical field. In a paper read in the Spring of 1939, before the American Society of Civil Engineers, Mr. Ammann stated: "Among its uncommon features are the application to such a great suspension span of a flexible stiffening system in the form of solid plate girders, and the design of the towers as rigid frames without any diagonal cross-bracing either above or below the floor. Both features contribute to the graceful appearance and structural simplicity of this type of bridge....This structural simplicity has in no small degree contributed to the unprecedented speed in the construction of the bridge." The bridge was built in 22½ months.

During the designing of the bridge, the matter of first cost had to be kept in mind all the while, and much study was therefore given to the question of whether the bridge should have sufficient width for four lanes or six lanes of traffic. It was found that six lanes would cost 3,000,000 dollars more than four lanes, and, according to Mr. Ammann: "In the expectation that a four-lane structure would have ample reserve capacity for many years, and that when traffic reached the capacity of the bridge, the construction of another crossing in that general vicinity would become justified, the four-lane alternate was adopted."

In agreement with the final plans, each of the two roadways was given a surface width of 27ft 6in between the centre-line barrier and the side kerb, and the steel kerbs, and the vertical sides of the central barrier were flared in each case so as to give a roadway width of 28ft 10½in. By means of that flare, at times of peak traffic of passenger automobiles only, it would be possible to carry three lines of such cars—leaving space enough between the two outside lines and the centre-line of vehicles for safe but necessarily careful driving at reduced speed. The flanking cars would then have to have their outer tyres in contact with the kerbs while making the crossing. The steel kerbs were provided for the wider floor so obtained at a cost of but 250,000 dollars. Motor trucks could not use the bridge when a roadway was in such service.

STIFFENING GIRDERS UNDER ERECTION

The potential traffic on the Bronx-Whitestone bridge for which the structure was designed was based upon a preliminary survey that was exceeded in actual volume of travel within two years after the crossing

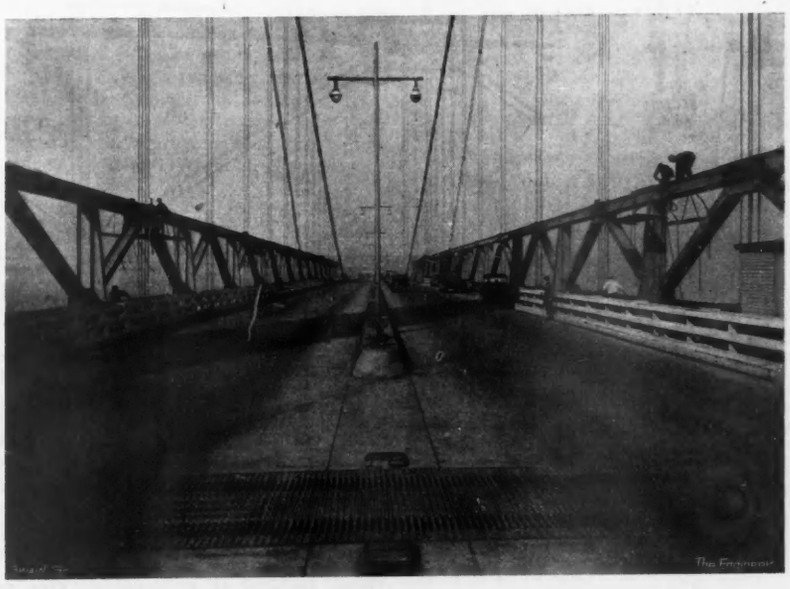
was placed in service. In 1941 as many as 517,000 vehicles used the bridge in the single month of December. Before anything could be done to relieve the situation, World War II intervened and made work impossible.

ERECTING TOP CHORD NEAR CENTRE OF BRIDGE

Furthermore, before such modifications could be taken in hand, the engineering authorities had repeated proofs that the flexible nature of the stiffening girders, although at no time indicating possible weakness, was a deterrent to three-lane traffic on a roadway. Indeed, plans for providing added stiffness to the bridge as well as provision for widening the two roadways were made ready in 1941, but as explained, could not be carried out. The postponed work was begun in June of 1946, and completed before the close of that year, with the exception of a part of the job of repainting the structure. This inevitably is controlled by weather conditions and will probably be finished during the Spring of this year.

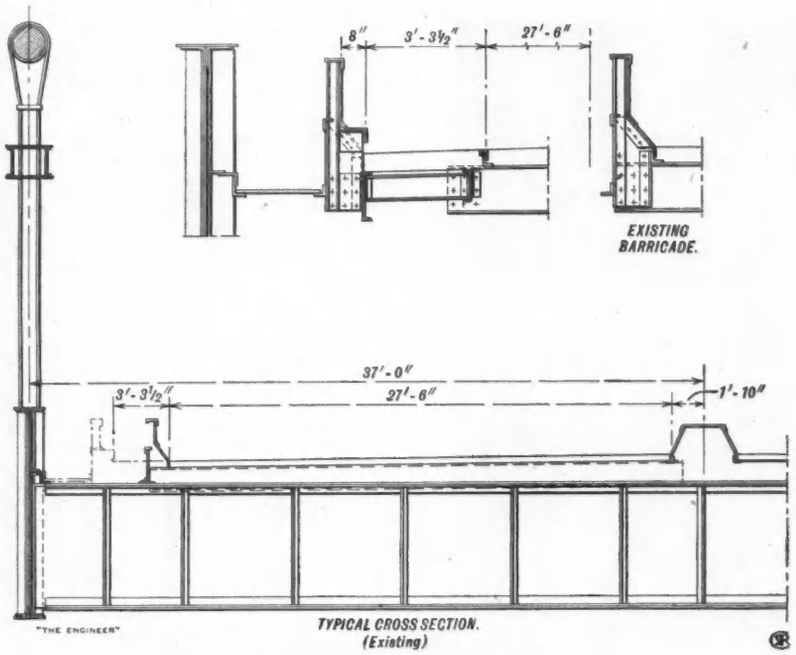
DELIVERING CONCRETE FOR ROADWAYS

The design of the Bronx-Whitestone bridge was primarily evolved around the need for giving the structure sufficient rigidity to meet all demands that might be made upon it in handling the maximum volume of traffic for which it was intended; and as Mr. Ammann has mentioned latterly, "possible oscillations under dynamic wind action were not in question." But it had become likewise apparent by 1941 that aerodynamic action had to be countered in some manner that would assure substantial reduction of disturbing oscillations. The first symptoms of such motions were detected in March of 1939, while the bridge was still under construction but nearing completion; and the demonstration came when steel forms used in placing the concrete slab of the roadways presented an unbroken horizontal area to the sweep of the wind. At that time, the centre span acquired vertical undulating movements. In most instances there was a "single node at the centre and with double amplitudes of between 2ft and 3ft at the portal points. They were accompanied by longitudinal motions of the floor, as observed at the towers," as stated by Mr. Ammann. The axis of the bridge lies approximately in a north-west–south-east direction and well-nigh invariably it was a north-westerly wind that induced the early motions—the wind striking the bridge at an angle of from 30 deg. to 45 deg. to the axis of the structure. When this occurred, the lifting impulse of the wind was further indicated by the strength of wind currents that swept upward and outside of any openings then existing in the bridge floor. To cure any trouble, it is necessary to know the cause and its actions. On this point, Mr. Ammann, in a second paper read before the American Society of Civil Engineers, thus expresses himself: "Subsequent developments have established beyond question that the predominantly vertical oscillating motions are induced by a more or less horizontal wind stream acting on the elastically suspended structure and are possible because of the inadequate vertical stiffness of the structure" It was hoped that with the completion of the placing of the concrete floor slab that the added deadweight would suffice to dampen the aerodynamic disturbances, but such was not the result. At intervals during the succeeding two years, various expedients were adopted successively to better matters in the way of stiffening the structure, and although measurably helpful, they were not deemed solutions of the problem. The bridge continued to move, given the requisite provocative conditions, though the order of the movements observed was lessened. Movements were not frequent; and such movements, when they occurred, were not too closely allied to particular wind velocity or wind direction, although quartering winds were more likely to produce movement. High winds had no effect. Winds of half-gale or less were more likely to produce motion, and movement was observed with wind velocities as low as 10 miles per hour. The double amplitudes of movements, when movements occurred, were usually less than 1ft.



NEW STEELWORK NEARING COMPLETION

Occasionally, movements reached 18in, rarely 2ft, and only on two occasions in seven years did they exceed 2ft. It was observed that only movements exceeding in double amplitude 1ft bothered most drivers. With these movements of larger double amplitude, the psychological effect on the average driver tended "to make the man at the wheel unnerved and uncertain in the handling of his car." The foregoing sums up the findings of Mr. J. E. Tonnelier, engineer-of-maintenance of the Triborough Bridge and Tunnel Authority. Logically, when circumstances reached the magnitude just alarm to some people, decided to take steps to correct as far as was reasonably possible movements of the span that would be a deterrent to motorists desirous of making use of the crossing. Therefore, the changes that have been made after careful planning are expected to be satisfactory in all desired respects. Messrs. Madigan-Hyland, acting as consulting engineers to the Triborough Bridge and Tunnel Authority, with Shortridge Hardesty M.Am.Soc.C.E., and O. H. Ammann, collaborating with the latter, have been responsible in determining the corrective measures that were adopted, and the mentioned, confusion and collisions were invited and traffic demoralised. However, the bridge as a structure was in no wise endangered or over-stressed.

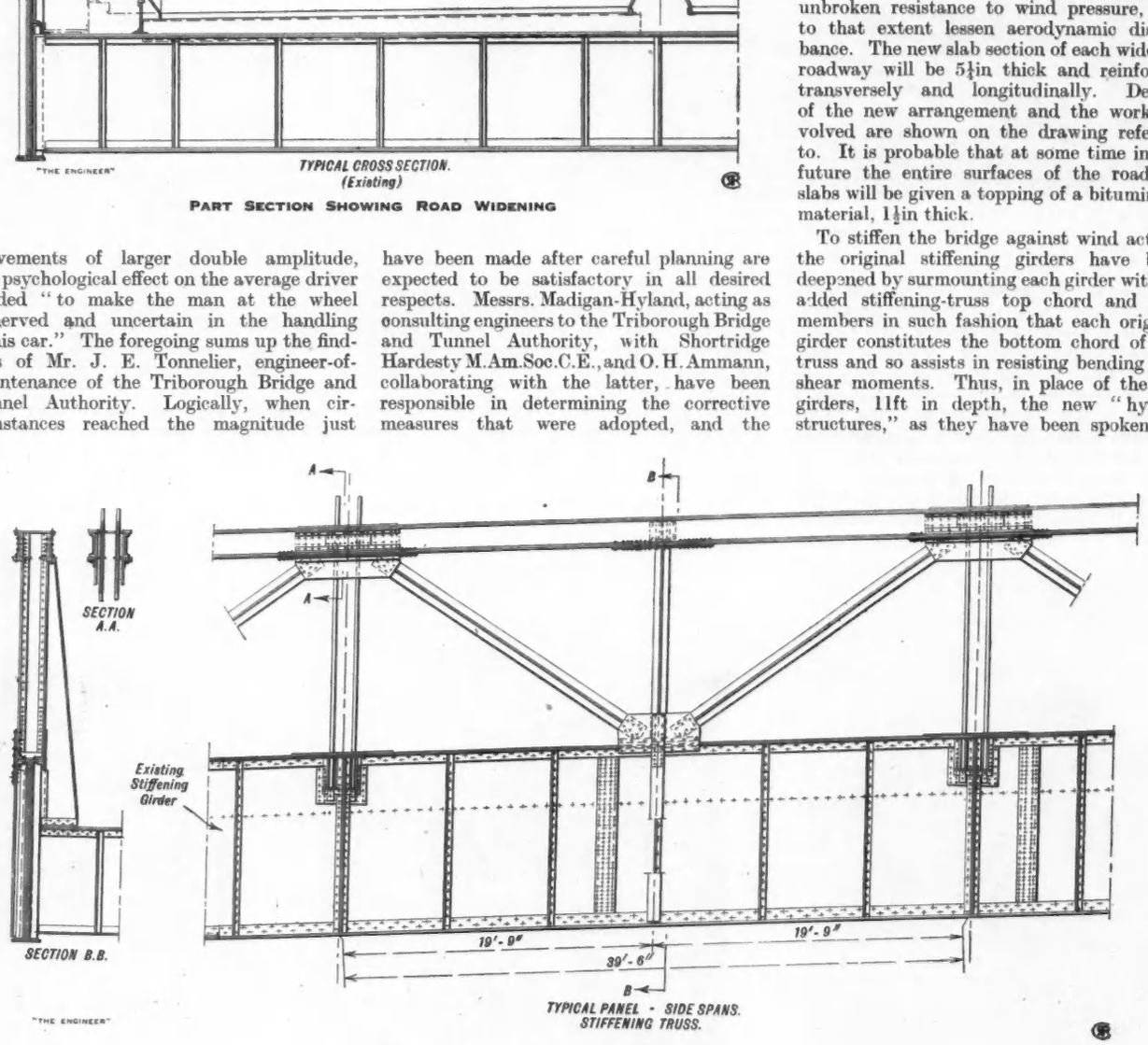


PART SECTION SHOWING ROAD WIDENING

The Triborough Bridge and Tunnel Authority, having caused some discomfort and even contract plans for the work were prepared by Madigan-Hyland. Fundamentally, the changes are two in number: the stiffening of the trusses and the widening of the two roadways by eliminating the footpaths. Each footpath originally had a width of approximately 5ft 6in.

The outer flanking kerb has been shifted 3ft 3½in outwardly into the space formerly occupied by the adjacent footpath and, therefore, each roadway will now have a width between kerb tops of 32ft and a pavement width of 30ft 9½in in the clear. This change will allow for three lanes of traffic; two 10ft lanes for automobiles and one 10ft 9½in lane for motor lorries. The lorry lane on each roadway will be the outermost one, where those vehicles can move at the customary speed for such vehicles, while the passenger cars on the two inner lanes will be able to run at their normal travel speed over the bridge at a rate of 35 miles an hour. The roadway changes have been duplicated on the side spans and on the approach roads. The manner in which the kerbs were to be moved and re-established can be seen on an accompanying drawing. The concrete slab which formerly served each footpath has been removed and the space remaining now carries a new galvanised metal grating. The openings will thus reduce the area formerly offering unbroken resistance to wind pressure, and to that extent lessen aerodynamic disturbance. The new slab section of each widened roadway will be 5½in thick and reinforced transversely and longitudinally. Details of the new arrangement and the work involved are shown on the drawing referred to. It is probable that at some time in the future the entire surfaces of the roadway slabs will be given a topping of a bituminous material, 1½in thick.

To stiffen the bridge against wind action, the original stiffening girders have been deepened by surmounting each girder with an added stiffening-truss top chord and web members in such fashion that each original girder constitutes the bottom chord of the truss and so assists in resisting bending and shear moments. Thus, in place of the old girders, 11ft in depth, the new "hybrid structures," as they have been spoken of, have an effective depth of 25ft throughout all but the midlength of the central span. In that short length, the top chord will taper toward the centre of the span and run parallel to and immediately beneath the cable. Although the modified girders cor-



TRUSS DETAILS OF REMODELLED SIDE SPANS

respond in depth to but $^1/_{92}$ of the length of the main span, they are deemed capable of providing the desired increased structural stiffness. Conversely, the engineers believe that this modification of the stiffening girders will not result in excessive stresses when exposed to the possible maximum combinations of live load, temperature changes, and wind actions.

Details of the stiffening truss and the manner in which it is tied to the original stiffening plate girder are shown on an accompanying drawing, which also supplies certain informative particulars. The truss top chord is stiffened laterally by welded brackets that extend above the floor beams. In doing the work the procedure was such that the suspenders from the cables and the existing diagonal stay-ropes were not disturbed. The new steelwork was assembled so that the suspenders and the stay-ropes could pass through the slotted openings in the webs and cover plates of the truss members, in order to permit freedom of motion. To guard against any damage to the suspenders and stay-ropes by their rubbing against any of the truss members, the ropes have been seized or covered at such intersections with soft, annealed galvanised steel wire of No. 12 gauge, and before the wire was applied, the suspenders at the points necessary were given a thick coating of red lead paste and then wrapped with two layers of 16 oz canvas.

Inevitably, the new truss members have lessened the apparent slimness of the span's lines, but they have not detracted from the structure's gracefulness. The truss members have increased the maximum moment of inertia per girder or truss to approximately 7½ times the original value. Considered in the order of resistance of the combined cable and truss system to deflection under a uniform load, the estimate is that the original rigidity of the structure has been increased relatively 60 per cent. That stiffness approximates that of a number of other well-known suspension bridges that are said not to have shown any noticeable oscillations due to wind action.

The contract for the work done on the Bronx-Whitestone bridge was let as a whole to the Woodcrest Construction Company, Inc., of New York City, which sublet various parts of the job. As the undertaking has involved preparations for a greater volume of traffic, considerable work had to be done on the approaches to the crossing, and that necessarily included landscaping, excavating, grading, draining, and other changes that had to be made, apart from the steel and concrete work on the bridge itself, and the repainting of the structure. The erection of the steelwork was started in June of last year and was completed during the first week of November following, but the last of the riveting was done a little later.

The structural steel handled totalled 5,500,000 lb; the concrete placed amounted to 430 cubic yards, and the reinforcing rods used in the concrete weighed 360,000 lb.

The contractor was obliged to keep at least 16ft of roadway in each direction of traffic open at all times, and continuously to protect the areas where work was being done by means of a longitudinal barricade of a design prescribed for that purpose. The barricades were of heavy timber and remained in position until the new work was completed. To avoid traffic interference, the contractor maintained a yard about four miles distant from the bridge, where steel, originally used on the bridge, could be revamped for re-use on the bridge, and where all new steel could be finally fabricated before removal to the bridge for erection. Instead of using wooden forms for the concrete placed on the bridge—which is common practice in such cases, the contractor used 12 gauge steel plate for that purpose and left the steel permanently in place after the concrete was poured.

Although the bridge was always well lighted during darkness, special precautions were taken to warn traffic on approaching points where operations were under way. This is usually done by using the familiar "bomb lights." The contractor, however, made use of electric lights energised from storage batteries where no regular circuit was available for tapping. This probably had much to do in preventing trouble that might have occurred on windy days when bomb lights might have been blown out. Some of the electric lights functioned as "blinker lights," which are more effective for warning purposes. The concrete was placed from mixer trucks, the unit load usually being about 7 cubic yards, and motor cranes handled the steel during erection. During holidays and week-ends, two traffic lanes were available for travel on each of the roadways. The contract price for the entire work, including painting, was approximately 1,400,000 dollars.

Messrs. Madigan-Hyland, engineers, were in charge of the improvements as the representatives of the Triborough Bridge and Tunnel Authority.

An Engineer Looks at Bolivia

By ROLT HAMMOND, A.C.G.I., ASSOC. M. Inst. C.E.

No. II—*(Continued from page 511, June 13th)*

The Bolivian Tin Mines

OVERBECK* has given us a vivid picture of the Bolivian tin mines, the highest in existence, some of them sited at an elevation of 15,000ft above sea level, where only the barrel chested Indian can work in comfort. It was not until after the liberation of Bolivia, in 1824, that tin became recognised as a valuable asset, for the old Conquistadores threw it away as worthless in the course of mining silver.

She describes how mining has been going on for 400 years in the bowels of Potosi Hill, where a peculiar code of mining laws developed, the principal feature of which was known as the "tunnel right." This allowed a miner to drive headings in any direction providing that he did not meet other workings. Many disputes arose, causing much bloodshed, and outposts were maintained to listen for any drilling or shot firing proceeding nearby. Rival claimants made openings in their enemies' drifts, shooting fumes of burning pepper or straw into them to drive out the men and hold up the advance. There were no mine maps available, and thus each man feared the intervention of his neighbour; mainly for this reason, spies were employed to creep through rival workings and gain some idea of what was afoot. Things came to such a pass that machine guns and armour plate doors were installed at mine entrances.

*"Tin, the Cinderella Metal," by Alicia O'Reardon Overbeck, in *The National Geographic Magazine* for 1940, pages 659, *et seq.*

The Patiño Mine

The story of how the famous Patiño concern originated forms one of the most romantic tales of the mining industry. In the early days of the present century, says Overbeck, a young clerk named Patiño was selling wool, calicoes, and hats for a German who owned a general store in the mountain town of Cochabamba; this store had a heavy debtor, a Portuguese, and Patiño was ordered to find him and collect the debt. After much difficulty, he found him, and the Portuguese offered a tin claim in settlement of the debt, which Patiño accepted. The German storekeeper took a very poor view of this transaction, promptly discharged Patiño, telling him in a rage that he could keep his tin claim in lieu of back wages.

For many months Patiño worked at the tin lodes, with only a few Indians to help him, living under the most primitive conditions imaginable; the time came when at long last he discovered a deposit of almost pure tin oxide, for which he was offered a million dollars. He turned down the offer and was able to buy the surrounding properties; these also proved to be rich in tin and formed the basis of the immense Patiño fortune.

The following table shows the countries whose outputs have been available to the United Nations since 1940; the Belgian Congo has increased its production to about 18,000 tons per annum, and Nigeria to about 15,000 tons in the same period:—

World Production of Tin in Long Tons during 1940

	Tons
Malaya	85,384
Netherlands East Indies	44,563
Bolivia	37,940
Siam (Thailand)	17,447
Belgian Congo	12,392
Nigeria	10,257
China	10,000*
Burma	5,000*
Australia	3,000*
Portugal	2,623
Argentina	2,000*
Africa	2,181
(Includes 581 tons for South Africa.)	
French Indo-China	1,500*
Cornwall	1,500*
Mexico	345
Peru	70
Other countries	1,600
Total	237,802

* These outputs have been partly estimated.

In 1944, out of a total of 38,719 tons of tin produced in Bolivia, 19,151 tons were contributed by the Patiño concern.

The Tin Research Institute

Proof that Great Britain realises the importance of this metal to industry is provided by the existence of the Tin Research Institute, a body founded, financed and controlled by the International Tin Research and Development Council, on which serve delegates appointed by the various Governments interested in tin production. The head office and laboratory of this organisation are at Greenford, in Middlesex; here there is a metallurgical wing, a chemical wing, and an administrative building. The latter includes a library of modern books, papers and technical abstracts, relating to tin and its many alloys. The staff is entirely devoted to a service of technical information and practical assistance in all industrial operations employing tin; this service is free to correspondents in any part of the world, subject to any Government restrictions.

An outstanding achievement in tin re-

search has been the successful application of scientific methods of control to the process of hot-tinning, hitherto operated on empirical lines; working instructions for this process have been issued in booklet form. Research has also been extended to solving problems of producing steel strip, special procedures having been devised with this aim. Many of the manufacturing difficulties formerly encountered in tinning have now been elucidated, and can henceforth be avoided by manufacturers of steel strip.

New methods of hot-tinning cast iron have been evolved, and bright, smooth protective coatings can now be obtained; this work has also enabled a firm metallic bond to be formed between white metal-bearing alloys and cast iron housings, thereby eliminating expensive grooving and dovetailing and giving improved bearing service. An advanced stage has been reached in research concerning manufacture of malleable bronze; information published to date enables high quality bronze containing up to 12 per cent of tin to be produced without difficulty. This new range of bronzes has a toughness and strength hitherto unattainable; methods of melting, pouring and casting have been so improved that lower grades of metal and scrap can be utilised; ingots are clean and free from tin-sweat, porous heads are eliminated. Thus, manufacturing costs are reduced and improved products obtained.

Study has also been directed to the problem of depositing tin coatings electrically, and the Institute has published working instructions for two modern tin-plating baths; this booklet contains full details of chemical control and of operating methods. The latter have already been widely adopted and have shown considerable improvement over earlier methods, which gave thin coatings of doubtful value. Coatings of tin alloy produced by electro-plating have also been developed; speculum plate, an alloy of tin and copper, has the appearance of silver and is capable of resisting corrosion to the same extent as chromium; it is suitable for indoor metalwork, tableware, lavatory fittings, and other components for houses and buildings.

The Tin Producers' Association

As long ago as 1929 the critical condition of the tin mining industry throughout the world led to the formation of the Tin Producers' Association, and to the institution of a Statistical Bureau for undertaking a detailed study of the industry†. For the six years preceding 1929, the range between the highest and lowest price of tin was never less than £60 in any one year; in 1924 it was nearly £100. The highest price in 1928 was £266 and the lowest £206 per ton, the average price being £227; this represented a maximum fluctuation of more than 26 per cent of the mean.

Price Stabilisation

In 1931 the first International Tin Buffer or Stabilising Stock was formed, and this gradually acquired a large part of the excessive stocks on the market; the price of tin then rose from about £100 a ton to a figure which enabled the producers to make a profit and at the same time to supply the metal to consumers at a reasonable price. The co-ordination of the tin mining industry has been extremely difficult, owing to the many interests involved; in the case of Bolivia, co-ordination was facilitated owing to the internal groupings which already existed on a large scale. In fact, we have here a remarkable achievement in international collaboration, which could well be taken as a model and applied to other commodities throughout the world.

It is interesting to reflect that the first attempt to stabilise the price of a primary commodity was made by the Tin Control, which not only serves the interests of producers, but provides a reasonable and stable price for both producers and consumers.

There is no doubt that both the Buffer Stock Administration and the International Tin Committee, by their joint action in 1939, effectively prevented an undue rise in prices, due to a buyers' panic in the United States. The International Tin Committee was able to reach an agreement with the United States which conferred substantial benefits on the United Nations, whereby the United States obtained 260,000 tons of refined tin in the two years, 1940–41, as compared with only 120,000 tons in the two preceding years.

According to Skartvedt‡, Bolivia's economic history has been characterised by alternate booms and slumps, due to fluctuations in the world's tin markets; he states that some of the answers to this problem may be provided by the Bolivian Development Corporation, formed for the purpose of working out a better system of utilising the immense natural resources of the country.

Bolivian Wartime Economy

During the war, the rôle of Bolivia has been that of a supplier of vital strategic materials to the United Nations; tin, tungsten, antimony, lead, copper, zinc, and many other materials have been transported in large quantities from the altiplano to the factories, and munition plants of the United Nations. Rubber has also been collected in the lowlands of the Beni and other tributaries of the Amazon by Indian "seringueiros" and transformed into tyres and many other products. Quinine for Allied soldiers in the malarial jungles of the Southern Pacific had its origin in the bark of cinchona trees in the Bolivian forests.

Great prosperity has come to the Bolivian mining industry as a result of the war. Although tin is the most important metal mined, since 1936 there has been a steady increase in the production of tungsten; in 1941 Bolivian tungsten accounted for about 11 per cent of the total world output. Although wolfram, the ore from which tungsten is manufactured, is mined throughout the Bolivian tin belt, it is rarely found in association with tin ores. As late as 1939, Bolivian tungsten was shipped almost entirely to European markets, but in May, 1941, the United States contracted to purchase, through the Metals Reserve Company, all tungsten produced in Bolivia, up to a total of 4000 tons annually, for a period of three years from July, 1941. There should be a bright future for tungsten, with an assured sale in the United States.

Mining of Other Metals

In 1903 the mining of antimony was started in Bolivia, and by 1915, the country had become second only to China in the world's production. Antimony deposits are found in many provinces and are not confined to one particular district. Lead and zinc are widely distributed along the central Andean mountain chain; during the past ten or twelve years improved transport facilities have made the mines more accessible, and improved metallurgical processes have made possible the recovery of higher grade products. It is believed that there are, in Bolivia, vast deposits of these metals; future expansion of lead and zinc mining will probably be hampered by the relatively greater importance of tungsten and tin, by shortage of mine labour on the lofty altiplano, and by the difficulty of obtaining suitable mining machinery.

Rubber Production

With regard to rubber Bolivia is second only to Brazil as a producer on the South American Continent; Bolivian rubber is derived almost entirely from the jungle trees of the "Hevea" family, which grow wild in the lowlands of the Amazonian tributaries. Rubber produced in the Beni district has always been acceptable by reason of its high quality, rivalled only by the world-famous "Acre fine Para" of Brazil. Although exports of Bolivian rubber reached their peak from 1912 to 1919, averaging 4870 tons per annum over that period, in recent years the annual rate of production has averaged less than 1000 tons.

Although manufacturing is on a small scale, the increasing cost of imported goods has stimulated its expansion; manufacturing is confined almost entirely to the production of foodstuffs and beverages, textiles, furniture, tobacco, glassware, chemical products, and other easily manufactured commodities suitable for local consumption. Owing to lack of cheap power, it is possible that Bolivia will for many years remain dependent upon imported manufactured goods. Increased prosperity in Bolivia will depend, as we have seen, on an integrated economy.

(To be continued)

† "International Tin Control and Buffer Stocks," published by the Tin Producers' Association, 11, Ironmonger Lane, London, E.C.2.

‡ "Bolivian Economy Thrives in Wartime," by E. W. Skartvedt, *Foreign Commerce Weekly* for March 13th, 1943.

Tests of Timber Beams

Varied research in the United States as to timber and plywood in construction has included tests of built-up timber beams with metal dowels to increase materially the horizontal shear strength. These tests indicate that deep beams may be composed of shallow sections dowelled together, and that beams weakened by checking may be reclaimed or strengthened by placing dowels in order to make their shear strength equal to that of uncheeked beams. In a series of twelve red-oak beams, six were plain and six reinforced, while some of the latter were built up to the same section as the plain or solid beams. All beams were 6ft long and 12in by 4in in section, but grooved or routed out on each side to a 1½in section for the middle 4in of the depth. The purpose of this routing was to ensure horizontal shear failure in the non-reinforced specimens and thus serve as control beams for the reinforced sections. When threaded rods were placed in holes of correct diameter a relatively high bond strength is manifested by resistance to withdrawal of the rods. While structural timber needs no mechanical aids to increase its strength in tension or in compression parallel to the grain, its strength in horizontal shear is not so satisfactory, so that it is often necessary to employ beams of larger size than are needed for the flexural stresses. With increased shear resistance, the bending strength of the smaller sizes can be utilised fully. Furthermore, where large timbers are difficult to procure, beams of required section may be built up if the fastenings are sufficiently simple for economic construction. Vertical dowels are as effective as inclined dowels and the work of preparing the holes and driving the dowels is much simpler when the dowels are vertical. For beams of 4in and 5in thickness, the dowels would be ½in and ⅝in, respectively, while a 6in beam might have two lines of ⅝in dowels.

Central Research Laboratory at Winterthur

DURING a recent visit to the works of Sulzer Brothers, Ltd., Winterthur, Switzerland, we had the pleasure of inspecting the firm's new central research laboratory, which was formally opened in 1945. The need for the centralisation of a number of research departments which were previously scattered through the works was realised during the very difficult days of the war. Plans were then made to use those years to carry out a scheme which, while centralising research effort, would unite the work of the scientific specialists, the designing offices, the workshops and foundries, and thus promote productive collaboration, thereby opening up new roads of advance and paving the way for fresh and valuable developments. For the varied technical programme of the firm makes it possible though obviously inexpedient for different departments to occupy themselves independently with the same scientific problems, or with the study of the same special fields, and the same practical data. Centralisation prevents such overlapping. But the consideration that more than one department may be interested in particular problems has led the firm to appoint, apart from the laboratories, certain specialists and work groups, which concentrate on fields of knowledge interesting to a number of technical departments. These groups serve as central authorities on problems arising in their particular fields. Initiative in departments is encouraged by close personal contact between technical departments and the specialists and by the aid of periodical lectures on the various subjects concerned. Specialists are allotted to the departments specially interested in their particular work; sometimes, indeed, their activities on research only represent a subsidiary duty.

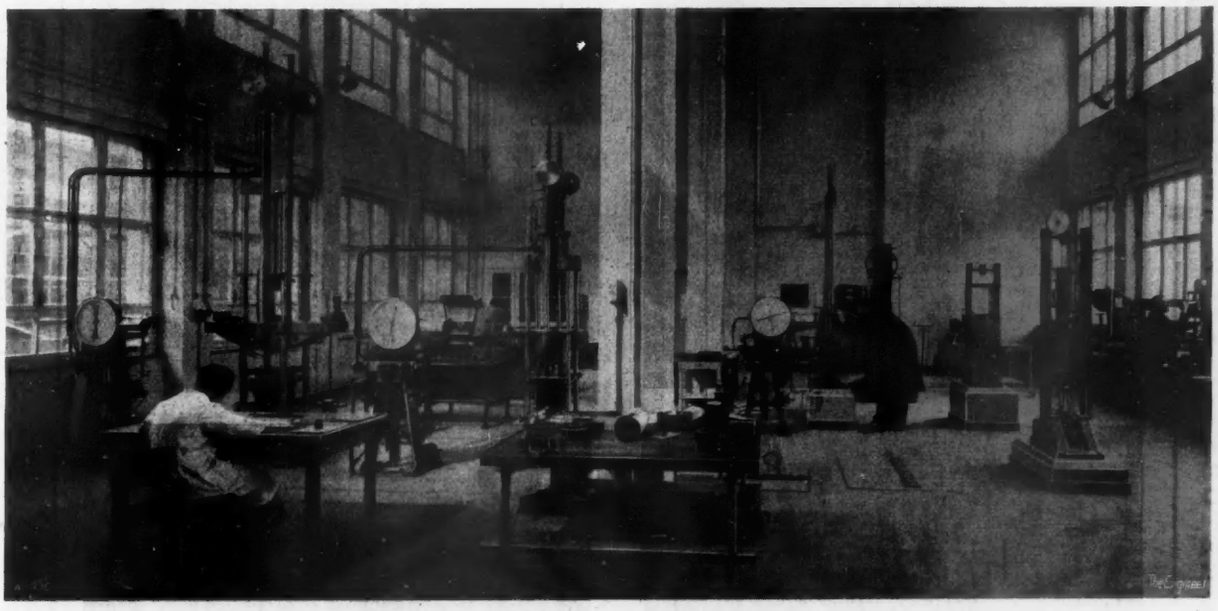


FIG. 1—MATERIAL TESTING MACHINE HALL

LABORATORY BUILDING

The single building which houses the new research laboratory has been erected in a central position in the works. It contains the machine hall and laboratory for the material testing department, and the chemical, physical and metallurgical laboratories. It is quite near the aero-dynamic and thermal laboratories, which were constructed separately before the research laboratory was erected.

The building is in brick, with ceilings of reinforced hollow construction, the latter so contrived that the pipes of the Sulzer panel warming system serve as reinforcing members. The ceiling panel heating system which has been adopted does away with the need for heating appliances on the walls or below windows. The laboratory is connected with the works district heating system by transformers. As waste heat from the works, at a low temperature, is available only intermittently, the low operating temperature and the heat storage capacity of the panel system are thus advantageous. Most of the rooms are equipped with ventilating plants, and automatic temperature regulation where necessary is provided. The air in all the rooms is kept slightly above atmospheric pressure, so that no dust from outside can make its way through the windows and doors.

The material testing laboratory with its heavy machines was allotted to the ground floor, and the machine hall (Fig. 1) takes up some space on the second floor. The basement contains the semi-technical laboratories belonging to the chemical and metallurgical departments, while a large room is set apart for the testing of heat resisting steels. Electrical distribution boards, compressed air and hot water plants are also accommodated in the basement.

The remaining space on the first floor is used for the physical laboratory, while the chemical and metallurgical laboratories are on the second floor. The attics are reserved for the ventilating plant, controls, stores, &c., and two lifts serve the various floors. Pipes for the services of coal gas, compressed air, steam, hot and cold water, are all accessible as they are mostly run in the removable ceiling of the corridor on the first floor, and from there run to built-up work tables in the chemical laboratories. Electrical energy is distributed through three-phase mains at 220V/127V, both mobile and stationary rectifiers being used to supply direct current. A system of screened mains connects the single rooms and the four principal laboratories for the purpose of transmitting measuring and thermo-electric voltages or signals.

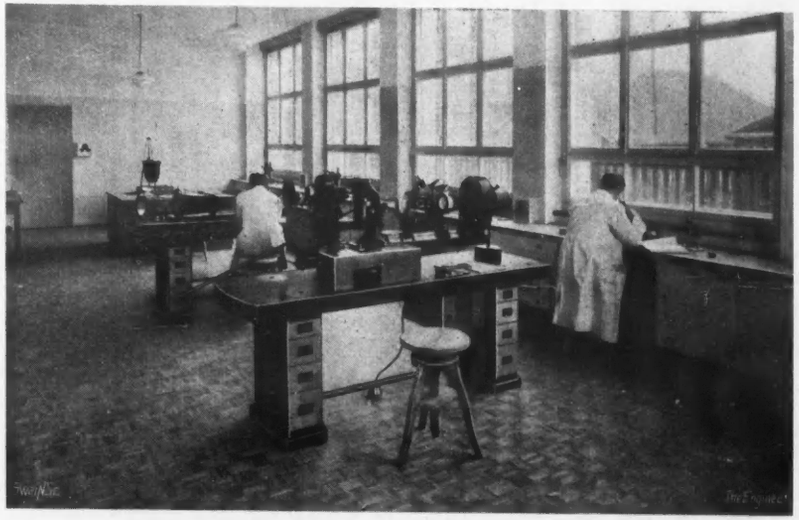
MATERIALS TESTING LABORATORY

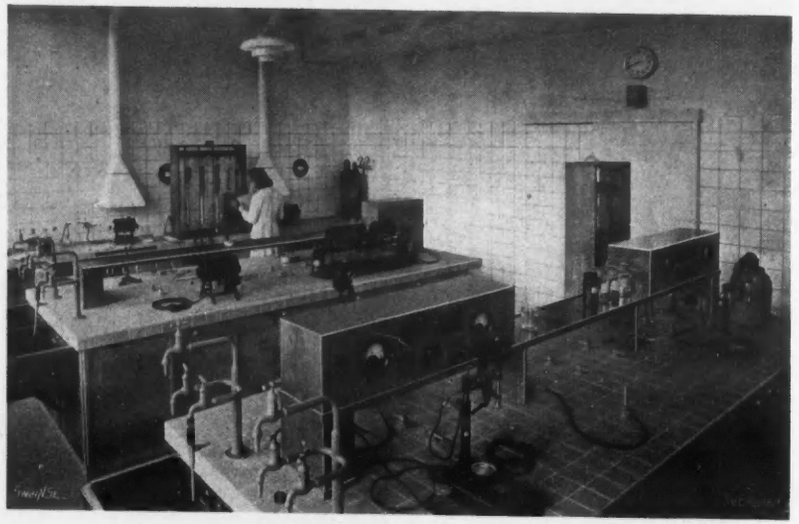
Views of this laboratory are shown in Figs. 1, 2 and 6. In the main machinery hall (see Fig. 1) there are three tensile testing machines of 10 tons, 30 tons and 50 tons capacity, respectively, which are available for static, tensile, compression, bending and shear tests. A folding or doubling-up machine, built for a maximum load of 50 tons, is also provided for standard sheet metal and steel tests. A further 15-ton press can be employed for particular bending tests such as, for instance, when stress has to be kept constant over a long period. Special apparatus designed by the firm is used for determining stress concentrations in fillets. Two balances are used for the testing of helical springs, which enable the load to be determined per 1mm of compressive bending. Static tests carried out at high temperatures, especially for endurance tests, are made on three special machines, which are installed in their own room, and allow tests to be made at temperatures up to 800 deg. Cent. Special machines for the same purpose have been designed by Sulzer Brothers for testing a large number of specimens at a time. Dynamic strength testing at room temperatures has been developed with alternating bending tests carried out with either rotating test pieces, or with flat bars swinging backwards and forwards, and these tests have been extended to tests made in corrosive media. Small elements can be tested as a whole for fatigue strength and dynamic tests with alternating bending tests on rotating test pieces can be made up to temperatures of 800 deg. Cent. For determining notch strength and for the carrying out of impact tests there are three pendulum machines of 15m-kg, 30m-kg and 75m-kg capacity. These are arranged for tests either at room temperature or at high or low temperatures.

For hardness tests (Fig. 6) apparatus consists of Brinell, Rockwell and Vickers hardness-testing machines. Plastic resistance to deformation is measured by macroscopic methods, and a special micro-hardness test has been devised by which the hardness of single crystals is measured.

The metallographic resources of the laboratory include a modern Zeiss microscope for metals, permitting magnification up to 1800 times for subjective observation. Other apparatus includes an epimicroscope and a special micro-

CENTRAL RESEARCH LABORATORY, SULZER BROTHERS, WINTERTHUR





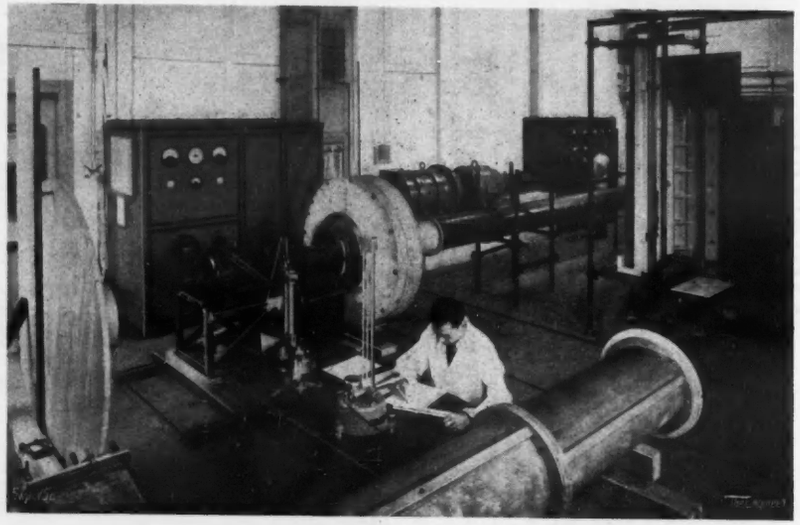


FIG. 2—LABORATORY FOR MATERIAL TESTING, MICROSCOPY ROOM
FIG. 3—PHYSICAL LABORATORY, GENERAL WORKROOM

FIG. 4—CHEMICAL LABORATORY, ELECTROLYSIS AND COMBUSTION ROOM
FIG. 5—TESTING ROOM IN AERO-DYNAMIC LABORATORY

scope for the transparent or reflected lighting of the specimen. This apparatus is shown in Fig. 2 opposite. Non-destructive testing methods include mobile and fixed X-ray plants and plants for detecting surface cracks on the magnetic powder system.

In the basement is a special room for sustained load rupture testing plant, designed to reveal the behaviour of a steel specimen under high temperature tests lasting several thousand hours. The machine, illustrated in Fig. 7, was designed to accommodate 100 specimens under simultaneous test. The load applied can be regulated by a hand-wheel on the control desk and varied from a few kilogrammes up to several tons. By means of an optical device, the elongation of specimens is measured under load, without having to remove them from the furnace. Single specimens can be inserted or removed from the machine without interrupting its work. These machines can quite well be built to take from 300 to 400 test specimens.

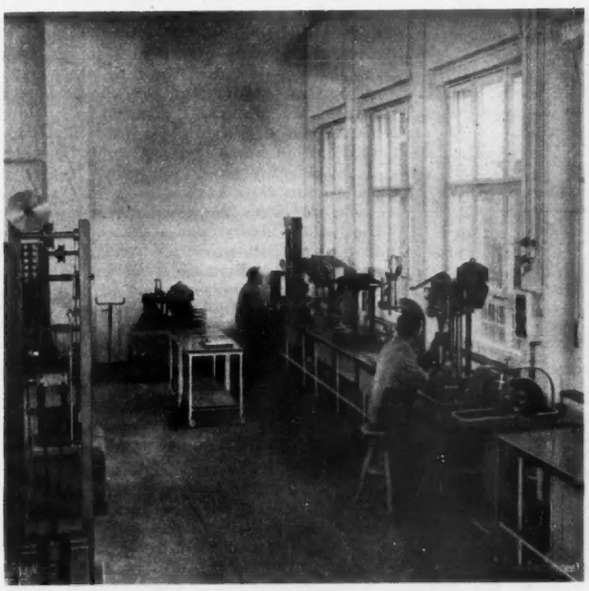


FIG. 6—MACHINE HALL SHOWING HARDNESS TESTERS

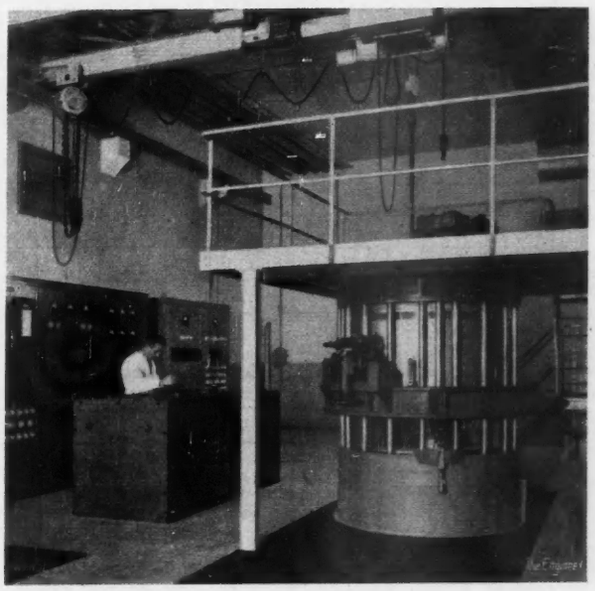


FIG. 7—SUSTAINED LOAD HIGH TEMPERATURE TESTING MACHINE

PHYSICAL LABORATORY

The work of the physical laboratory represents advances made in the study of applied physics during the last ten years. In 1926 and 1927 Dr. G. Eichelberg studied for Sulzer Brothers the variation of heat stresses and temperatures in a running engine and pressure fluctuations were recorded. Newer apparatus includes the spark stroboscope and oscillographic apparatus, which are employed on various test beds. Apparatus of this type includes a mobile high tension truck for the spark stroboscope, a mobile, six-loop oscillograph and a single and double-ray cathode-ray oscillograph. A dark room for the development of oscillograms is provided. A sound-proof room for carrying out vibration tests on turbine and compressor blades is also available. A view of a general workroom in the laboratory is reproduced in Fig. 3 opposite.

CHEMICAL LABORATORY

A wide range of tests is catered for in the chemical laboratory. Up-to-date apparatus and equipment for making rapid and accurate analytical tests with metals and other substances is, of course, available, and a special room is set apart for lubrication problems. For lubricating greases, accurate values of consistency at high or low temperatures are given by the Höppler consistometer with which the elasticity of rubber and its plastic deformation can also be tested. We show, in Fig. 4 opposite, a view in the electrolysis and combustion room. Investigations are also made into the properties of fuels such as oils, coal, wood and generator gas, and boiler waters from all parts of the world. Many tests on mineral specimens and substances of differing kinds used in the works are made.

METALLURGICAL LABORATORY

The metallurgical laboratory, on the second floor, includes the offices and laboratories, while in the basement are the rooms for the examination of moulding sand, and for annealing and melting tests. Quantities of metal weighing from 100kg to 150kg can be dealt with by the melting and annealing furnaces and the quenching baths. There are also other furnaces for dealing with smaller quantities of metal. Provision is made for the testing of foundry sands and other refractory materials. Three-phase and single-phase alternating current are available, and also compressed gas and compressed air for furnace heating. Ample lifting appliances are fitted in the furnace room. Furnaces include an arc-melting furnace and medium frequency furnaces, which can be worked singly or in combination. A high-temperature electric furnace of the Nernst-Tammann type is used for melting tests and refractory tests. Crucible furnaces heated with compressed gas or retort graphite are also available. Forgeability is tested by means of an electrically driven spring hammer, having a tup weighing 100kg.

For heat treatment there is an electric muffle furnace for temperatures up to 1000 deg. Cent., and an electric shaft furnace with air circulation for temperatures up to 800 deg. Cent. For the temperature range from 1000 deg. to 1500 deg. Cent. a muffle furnace heated by gas under pressure is employed. Quenching baths of salt, lead, oil and water are available. The moulding and core sand testing section includes a sand slinger and vibrating sieve, and an electrically heated drying chamber. Apparatus for testing flow capacity, permeability to gas, hardness, shear and compression, bending and tensile strength have been specially designed and made in the laboratory. In the thermo-metallurgical section of the laboratory tests are carried out with comparatively small quantities of materials. The office for recording and evaluating metallurgical test figures contains a Hollerith card index, with data on chemical investigations and strength figures, and a drawing table. There is also a calculating machine for evaluating the test results by the methods of mathematical statistics.

AERO-DYNAMIC LABORATORY

The aero-dynamic laboratory staff gives up part of its time to the study of departmental problems, and the balance to long-term research work. A view in the laboratory is reproduced in Fig. 5 opposite. In the compressor room there is a single-stage test bed for compressor blading and a multi-stage axial compressor. The construction of both plants permits of measuring instruments being inserted for investigating the conditions of flow inside the machine. Facilities are further provided for modifying and exchanging the various elements. The blades used on the single-stage test bed are made of wood and are formed on a copying milling machine, developed by Sulzer Brothers. The best forms are then examined in the multi-stage compressor in order to determine their behaviour under service conditions.

Next to the compressor laboratory is a long room with a single-stage turbine test bed, a small wind tunnel, and a 10m long water tunnel used for flow tests. The laboratory has its own workshops for wood, metal work and fine instrument making and to a large extent it is independent of the main works. In the office on the top floor designs are prepared, results worked out, and theoretical investigations made. Store rooms for apparatus and measuring instruments are provided.

THERMAL LABORATORY

The purpose of the thermal laboratory is to further industrial research and development in the fields of steam generation, heat utilisation and the design and construction of governors. Single rooms are provided with steam at various pressures, water, compressed air, coal, and producer gas and electricity all of which are supplied from a central distributing point in the basement. Boilers include a mono-tube boiler plant for very high temperatures, and an electric boiler for internal steam supply and for testing purposes. Further equipment includes a concentrating plant and apparatus for the investigation of dust. The arrangement is such that there is room for the erection of special testing equipment, as needed from time to time.

The range of problems it is sought to solve in this laboratory is perhaps best indicated by the scope of the test equipment we have mentioned. Great emphasis, we gather, is laid on research work connected with the development of steam generators, thermal apparatus, and regulating systems. It is possible, we understand, to obtain from the experiments carried out not only data for calculation and design, but also a certain measure of working experience.

The Iron and Steel Development Plan—Some Statistical Considerations*

By R. M. SHONE

No. I

Introduction

THE paper will fall into three main sections, all concerned with different aspects of the Steel Development Plan. The first sets out some of the information bearing on the estimation of the future demand for steel; the second deals in the main with the estimation of future supplies of scrap; and the third describes the progress made in implementing the Plan since it was considered by the Government a year ago.

[Of these sections, extracts are here printed from the first and last, whilst the second is wholly omitted.]

Demand for Steel

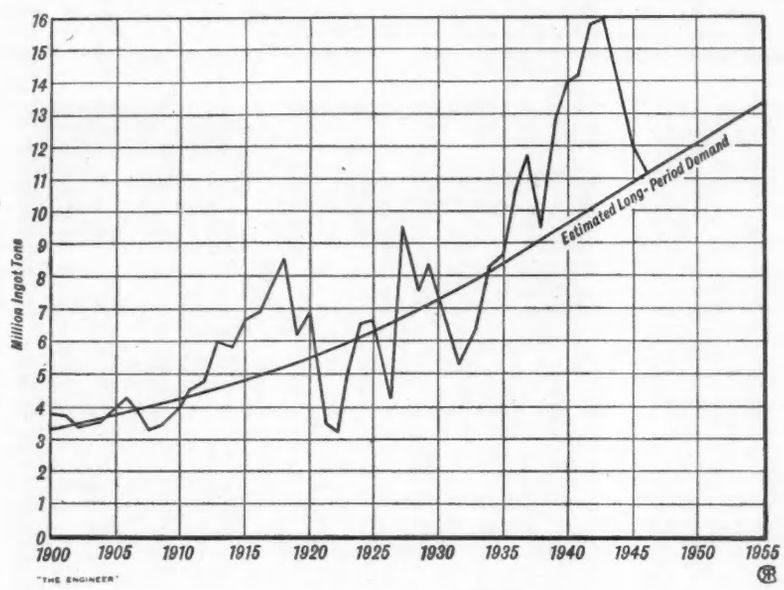
Approximate estimates of the probable future demand for steel were given in the industry's Development Plan which was published as a White Paper.† These formed the basis of the future capacity of the industry which was aimed at in the Plan. The total demand in the five years 1950 to 1955 was estimated to reach 16 million ingot tons a year, consisting of 13 million tons for home requirements and 3 million tons for direct export. The former figure, of course, includes the steel going into manufactured products for export. The broad basis of these figures was given in the White Paper, but fuller information may usefully be given on certain points taken into consideration in arriving at the estimates.

Long-Term Trend.—The figure of 13 million ingot tons for home requirements was supported by the long-period trend of home deliveries of steel prior to the war. Although there were wide fluctuations from year to year, there was a strong upward movement during the period. The figures which have been plotted herewith bring this out clearly. A free-hand trend line has been drawn on the chart and if this is projected forward without taking account of either of the two wars, it gives a figure of about 13 million ingot tons as the estimated annual requirement in the period 1950 to 1955.

The sharply rising trend in the quantity of steel used in this country is related to the industrial development of the period 1900 to 1946. The increase in the use of machinery in industry and agriculture, the growth of mechanical equipment in offices and the home, the rising volume of transport, the rapid development of the private car and the great expansion in electrical generation and distribution—all these factors combined to increase the use of steel.

Since this kind of development was common to most industrial countries, it is not surprising that the upward movement of steel consumption per head of the population is repeated in other principal industrial countries, as illustrated in Table II.

In view of the preponderance of heavy industry among the consumers of steel and the fact that the activity of the durable goods industries fluctuates more widely than production as a whole, changes in steel production and consumption prior to the war had a greater amplitude than the movement of general industrial production. The tendency for fluctuations in the country's economy to be reflected even more violently in steel production has created special difficulties for the steel industry in view of the high ratio of fixed capital to turnover which characterises the industry.



DEMAND FOR STEEL, 1900–1946

Consumption by Industries.—In considering the future demand for steel an attempt has been made to analyse the steel consumption by the main consuming industries. It has always been difficult to secure reasonably accurate figures on this subject and prior to the war no comprehensive information was published.

TABLE II.—*Estimated Steel Consumption* Per Head of the Population in Certain Countries*
(Ingot pounds)

	1914.	1929.	1932.	1935.	1937.
United Kingdom	307	411	245	409	550
U.S.A.	504	992	242	581	805
Germany†	395	379	132	431	509
France‡	124	414	247	224	300
Belgium-Luxembourg ...	—	453	249	235	366
U.S.S.R.	—	87	95	184	237
Japan§	44	137	97	162	220

* Steel available for home consumption.
† The figures include the Saar for all years, but otherwise refer to post-1920 frontiers except for 1914.
‡ Includes Alsace-Lorraine except for 1914.
§ Home islands only.

There is, however, a basis for estimating industrial consumption fairly closely in the Census of Production Report for 1935, which gives considerable detail and covers approximately 90 per cent of the total steel deliveries in the United Kingdom. On the basis of these figures and of partial information yielded by the Census of Production for 1924, 1930 and 1937, Table I has been drawn up setting out estimates of steel consumption by the main using industries.

Future Home Requirements.—In forecasting the future requirement, it has been found best to consider the probable trend of demand for each of the industries given in Table I. In total, a home requirement of 9¾ million tons of finished steel has been arrived at, or about 13 million ingot tons. This estimate of 13 million tons compares with deliveries in 1946 of 11,132,000 ingot tons. During the course of 1946, however, as conversion of using industries neared completion, requirements rose, and in the fourth quarter of 1946 steel was being delivered at the rate of 12¾ million tons per annum. There seems little doubt that, with the existing labour force in the metal-using industries, the trend of consumption would have continued upwards during 1947 and over 13 million tons would have been required for home consumption. In part, the high demand envisaged in 1947 is associated with the overtaking of wartime arrears and may not be a good guide to the more permanent level of steel requirements when these arrears have been worked off. The year 1937 to some extent was also one in which capital construction was at a peak level and no doubt contained some element of arrears carried over from the previous slump, and, to a limited extent, particularly on the constructional side, showed the early effect of the rearmament programme. Nevertheless, it is probably the best single year on which to base considerations of the future

TABLE I.—*Estimated Direct Consumption of Steel by Industrial Groups in U.K.*
(Thousand tons)

Industry.	1924.	1930.	1935.	1937.
Shipbuilding and marine engineering	925	880	540	840
Building and constructional engineering	670	920	1,375	1,725
Mechanical engineering	780	820	880	1,180
Electrical engineering	100	120	180	235
Motors and cycles	185	270	440	550
Aircraft	2	5	10	25
Railways and railway carriage and wagon building	600	565	610	760
Collieries	200	250	330	360
Hardware and hollow-ware	350	500	685	790
Rivets, bolts, nuts, screws, chains, springs and miscellaneous forgings	400	450	510	630
Wire and wire manufactures	300	300	400	500
Other	363	395	540	685
Total finished steel	4,875	5,475	6,500	8,280
Ingot equivalent	6,500	7,300	8,670	11,040

NOTES.—The estimates for 1935 are in general based on data given in the Final Report of the Fifth Census of Production, but with an allowance in respect of firms excluded from the Census inquiry. The estimates for 1924 and 1930 have been calculated on the basis of data published in the 1935 Census Report. For collieries the figures are based on deliveries of colliery arches, girders, &c.

The figure included under "Wire and Wire Manufactures" is an estimate (based on the Census figures) of the quantity of finished materials passed on to the metal-using industries, with an allowance for exports and imports. To avoid double counting, wire and its products are therefore excluded from the consumption figures for the separate industries.

The final item, "Other," includes four minor trades covered by the Census inquiry—tools and implements, cutlery, needles, pins, &c., and small arms, as well as an estimate for the following uses: tinplate used by canners making their own cans and by toy makers; direct purchases of steel by gas, water and electricity supply undertakings; tram rails; direct munitions requirements; direct purchases of steel for repair and maintenance work by the steel and other industries, which do not use steel as a raw material, but only for repairs and maintenance.

* Royal Statistical Society, May. Abstract.

† *Iron and Steel Industry.* Reports by the British Iron and Steel Federation and the Joint Iron Council, Cmd. 6811.

pattern of demand. In relation to 1937 it appears reasonable to estimate increases in mechanical and electrical engineering and in the motor and cycle and the aircraft industries, on the grounds of the contribution which these industries will be required to make in the future to increase exports. In engineering generally, increases should also result from the greater mechanisation of industry which will be necessary to achieve a higher level of industrial productivity in this country.

Although in certain directions substitutes may well be found for steel, there is also likely, compared with 1937, to be some maintenance of the present substitution of steel for other materials. It is probable, for example, that there will be some permanent increase in the proportion of steel used in collieries in substitution for timber pit props and possibly in the proportion of steel for wooden sleepers. Moreover, the development of the use of steel for furniture and office equipment as well as for domestic purposes, including refrigerators and kitchen equipment generally, is likely to expand consumption under the hardware and hollow-ware categories, as well as to add further to the miscellaneous steel uses. The steady expansion in the use of tinplate for containers is also likely to continue in the future. Ordnance requirements before the war were mainly included under the miscellaneous heading and some increase, with conscription and much more highly mechanised Forces, appears likely here. While no doubt some of these anticipations will be falsified by events, taken overall they appear to justify the assumption that home demand will reach a level requiring an ingot production of 13 million tons.

In projecting forward trends regard must be had to the fact that in the decade 1950 to 1960 population is expected to reach its peak and commence to decline. The impact of this stability and subsequent decline on the capital goods industries is an important factor likely to moderate the extent of increases in steel demand. For a number of years, however, the effect of this factor may be largely offset by the maintenance of employment at a higher level than before the war.

Direct Exports.—Future direct exports of steel have been estimated at an average of 3 million ingot tons a year. They fluctuated widely in the inter-war period, the average over the ten years prior to the war being 2¼ million ingot tons. Considerable expansion in recent years has taken place in the local production in many of our largest export markets. In Australia, Canada and India expansions of capacity have taken place which exceed their pre-war imports. A doubling of the South African steel industry is planned, as well as important extensions in India and the Scandinavian countries. Production has been started in Turkey, and South American countries are also developing their steel production.

Table III compares production in 1937, which was generally the year of greatest pre-war production, with the highest level of production since reached in a number of countries which were important markets for British steel pre-war.

TABLE III.—*Production of Steel Ingots and Castings*
(In thousands of tons)

	1937.	Peak production.
Canada	1403	2777 (1942)
Australia	1169*	1700 (1942)†
India...	895	1402 (1943)
South Africa	332	525 (1945)
Brazil	72	420 (1946)‡

* Year ended June 30, 1938.
† Year ended June 30, 1942.
‡ Annual rate based on production, August-October, 1946.

In addition, America built new capacity of about 15 million ingot tons during the war period. In the five pre-war years annual steel production in America averaged only 37 million tons, whereas present capacity is some 85 million tons. Against the increases in available capacity in relation to pre-war consumption must be set the further prospective growth in world consumption of steel and the probable limitation of exports from Germany.

On balance it appears unwise to budget on a very substantial expansion of direct steel exports, particularly under conditions in which British coal prices, now the major single cost factor in steel production, have increased relatively out of line with American coal. The estimate of 3 million ingot tons represents an increase of 51 per cent on the 1938 exports of 1,985,000 ingot tons. In addition, it may be possible to increase further the proportion of higher-valued products in steel exports. Already exports of alloy steel bars and rods in 1946 were 17,577 tons, nearly four times the 1938 figure. Moreover, in the Steel Development Plan, special attention is being given to expansion of tube production in order to meet heavy export demands and to developments in other steel finishing trades, for example, in tinplates and tyres, wheels and axles, where the product is of high value and the proportion of exports substantial.

The general trend towards the export of a higher proportion of the more highly valued products was an important feature before the war. The export of products valued at £24 per ton and over in 1938, namely, tubes, tinplate, wire, castings, forgings, tyres, wheels and axles and alloy steel, rose from 23·8 per cent of the total tonnage of steel exported in 1920 to 31·8 per cent in 1930 and 43 per cent in 1939. Further continuation of this trend may well mean that steel exports will reach the target of a 75 per cent increase in value over 1938, measured in terms of 1938 prices, with a smaller proportionate rise in the crude tonnage figure.

Steel Imports.—In the inter-war period steel imports fluctuated widely, reaching a high peak level of over 4 million ingot tons in 1927, immediately following the general strike, but in many other years amounting to almost 3 million tons. The importation assumed in making the post-war plans is 500,000 tons. The tendency is for steel to be readily available in periods of less active trade when there is a surplus of world steel capacity. Imports in these years can be obtained in very large quantities, but in times when demand for steel is heavy, imports are difficult to secure, as at present, and the prices at which they are available tend to rise above the British home trade price. In formulating a long-term plan, particularly for an industry in which fixed capital in relation to turnover is so high, it is important that imports should be planned on a basis that avoids temporary inflows of large surpluses from other countries just at the time when home demand is contracting and reliance being placed on a tonnage which cannot be secured in periods of peak demands.

(To be continued)

The Institution of Mechanical Engineers

THE banquet at Guildhall in the City of London on Friday evening last brought to a successful conclusion the Centenary Celebrations of the Institution of Mechanical Engineers. It was attended by a company of approximately 650 members, delegates and guests, including the Lord Mayor of London and the Lady Mayoress and the Prime Minister (the Right Hon. C. R. Attlee) and Mrs. Attlee. The President of the Institution (Lord Dudley Gordon) was in the chair. Following the loyal toasts, Dr. H. J. Gough, F.R.S., a Vice-President, proposed the toast of "The Corporation of the City of London," and in the course of his speech recalled with gratitude and pride the merchant and craft Guilds of the City, saying that we were indebted to them for their primary aims of good quality, skilled workmanship and the high reputation of the crafts that they represented. In replying, the Lord Mayor (Sir Bracewell Smith) expressed pleasure that the Institution of Mechanical Engineers had found Guildhall a suitable place in which to end its Centenary Celebrations. He hoped that those present would take away the knowledge that the City did welcome such centenary celebrations, because it felt that Guildhall was a fitting place in which to hold them. The toast of "The Institution of Mechanical Engineers" was proposed by the Prime Minister (the Right Hon. C. R. Attlee, M.P.), who reminded the company that in the development of the machine age, the British engineer went all over the world, helping other nations into the machine age, introducing the British machine, creating a demand for British products, and winning that high reputation by reliability and quality which he believed was still held to-day. In this country, the Prime Minister continued, we had a great tradition of skill in engineering, and he believed that we still held our own in the forefront for skill and specialised work. The Institution had played a great part in building up the traditions and the standards of a great and honourable profession, and although it was a hundred years old, it showed no signs of decrepitude. The Institution was something more than just the sum of its members, for it was the representative institution of a great craft. In acknowledging the toast, the President (Lord Dudley Gordon) took the opportunity to review some of the events in the week's celebrations and also to pay a well-deserved tribute to the Secretary (Dr. Guy) and the Institution staff for the remarkably efficient way in which the celebrations had been organised. A final thought of the week, which, he said, as President he commended, was pride in the achievements of our predecessors and gratitude not only for the example which they had shown but for the fact that we lived at a time when we had a great opportunity for a further advance in our science for the benefit of mankind. The last toast of the evening was that of "The Delegates and Other Guests," which was graciously proposed by Sir Claude Gibb, F.R.S., a Vice-President, and responded to in a delightfully humorous speech by Dr. R. V. Southwell, F.R.S., Rector of the Imperial College of Science and Technology. During the evening a programme of music was presented by the band of the Royal Electrical and Mechanical Engineers.

BOOKS RECEIVED

Mechanics of Materials. Second edition. By P. G. Laurson and W. J. Cox. New York: John Wiley and Sons, Inc., 440, Fourth Avenue, N.Y., U.S.A. Price 4 dollars.

Applied Mathematics for Engineers and Physicists. By Louis A. Pipes. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, Aldwych, W.C.2. Price 27s. 6d.

The Theory of Functions of Real Variables. By Lawrence M. Graves. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, Aldwych, W.C.2. Price 20s.

Introduction to Aeronautics. By C. F. Toms. London: Charles Griffin and Co., Ltd., 42, Drury Lane, W.C.2. Price 40s.

Cubicles and Control Desks. By F. T. Bennell. Manchester: Emmott and Co., Ltd., 31, King Street West. Price 2s. 6d.

BRITISH GEAR MANUFACTURERS' ASSOCIATION.—The annual luncheon of the British Gear Manufacturers' Association was held last Tuesday, June 17th, at the Savoy Hotel, London. About 70 members and guests were present, the representation of member firms being 100 per cent. Mr. N. Rowbotham, C.B.E., President of the Institution of Production Engineers, congratulated gear manufacturers on the combination of lightness, efficiency and reliability in their products. In aero engines some components, which were the most reliable parts of the engine, had not been altered in design for 20 years. Continuing, he stated that politics were threatening the aircraft and engineering industries. He likened politicians to weeds and plantains, which required the application of potent weedkillers as often as was necessary. The production of quality goods was not possible under quantitative controls. Mr. R. J. McLeod, Chairman of the Association, replied, stating that the Association, which represented 90 per cent of the industry, was formed three or four years ago, and sprang from the Export Group. Discovery, invention and production must be encouraged, he said, and not denied its just rewards. More rapid production was the engineer's job and would solve our problems.

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NOTICE TO READERS

All letters intended for insertion in THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.

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HUMAN RELATIONSHIP IN INDUSTRY

IN this issue we print another article from the pen of Mr. A. K. Rice, who, it will be recalled, contributed a provocative article to our issue of December 27th last, entitled "Where Do We Go from Here?" Mr. Rice, who in this instance has collaborated with Mr. J. J. Gillespie, writes about this second contribution that "following the storm raised by the previous article" it "might provide some reassurance in that it does give the method of reducing this intangible and awkward subject of human relationships to a form which is familiar to the engineer." We wonder whether engineers will find themselves able to agree with the authors' arguments and conclusions.

No one, we think, will have much fault to find with the opening of the article. There is no doubt whatever that, if an organisation of any size is to operate satisfactorily, lines of authority and communication and spheres of responsibility must be laid down. It is also clearly true that as a consequence of inevitable changes and developments, there is created the danger that the pristine clarity of the original organisational scheme may become clouded. New departments need to be created; and older ones grow in importance, with a consequent need for readjustment of relations with other departments. Moreover, new personalities arrive and have to be fitted into the organisation, and older men retire. An organisation is a living thing subject to change. Charts of organisational structure can, as the authors say, "often reveal anomalies of administrative practice and divided authority which have developed unwittingly during the growth of the company." It is one of the jobs of management to recognise the need for adjustment. But it is in the latter part of the article that engineers and managers may find material with which to disagree. What the authors term the "texture" of the organisation, the human relationships between its various units, is, we believe—as they, too, clearly believe—of greater real importance than the nature of the organisation itself. But the nature of the organisation unquestionably affects the texture. It can be, for instance, too severe. To lay down too critically lines of communication and limits of responsibility relating to each position may make it difficult for talented juniors to prove their capability by independent initiative and judgment. Nor must the limits be drawn too loosely, lest superiors be unwillingly committed to undesired courses of action through excessive zeal on the part of juniors and lest chaotic conditions of divided responsibilities arise. Either of such conditions can give rise to irritation and frustration with a consequent influence upon texture. The relationships between individuals comprising an organisation are therefore to some extent ruled by the very nature of the organisation itself and the interpretation put upon that nature by the various executives. We therefore think the authors, in their concentration upon the texture of human relationships have been tempted into an under-estimate of the influence upon these relationships of the organisational structure itself. For under a changed organisational plan human relations between the individuals concerned might be very much altered for better or worse. The inclusion, for instance, of representatives of the workers upon executive or consultative committees, deciding upon managerial questions or advising upon company policies, would amount (in some firms has already amounted) to a substantial change in structure and would certainly have considerable influence upon human relationships throughout a company.

But the part of the article which practical engineering managers will find peculiarly provocative is, we think, that concerned with the use of a chart of human relationships. It is not very difficult to draw up some such classification of human relations as that listed by the authors. But is not their application of such a classification to the units of an organisation too facile? Is the classification itself really sound? Does not the chart assume altogether too readily that the relations between any two individuals are persistent and unalterable? Is not the very compilation of the chart too inexact a process to make the results worthy of much respect? No doubt strongly antagonistic and deeply affectionate relationships tend to persist amongst individuals through all events. But in large organisations such strong relationships are in a small minority. Amongst and between the greater number of the people concerned feelings will vary from day to day and even from hour to hour. It is certainly true of an eleven that it can play glorious football one day as a team and fail lamentably on another day, through the unexplained absence of that same team spirit. How much more true it must be of a greater organisation pursuing a far more complicated purpose that the performance of its parts shall always diverge to some widely variable degree from that perfection which is the consequence of the maintenance of team spirit! We do not doubt for a moment the value, which should be impressed upon all managerial staff, of watching human relationships amongst juniors and endeavouring to correct by any convenient means any persistent failures of co-operation that may occur. But we do doubt whether the drawing up of a chart, such as the authors describe, can serve better to reveal to high executives what they should with less difficulty be able to discover for themselves through their ordinary contacts with their juniors.

THE ROBOT POPULATION

SOME interesting deductions can be drawn from recent reports on the water power resources of Canada, which is now one of the leading, if not the foremost, of all the countries in the world in respect of electric power generated per unit of its population. It is natural to relate this abundant supply of mechanical power to the total manpower of that highly favoured country, and to see how other countries stand in this same respect. A comparative ratio which we may use is that of the man-hour equivalent of the electrical supply to the efforts of the human workers, or how many electrical robots has each citizen to help him in his daily life. The ancient Roman civilisation was, we know, largely based on slave labour, and owing to its long series of successful wars ranging over most of the then known world, the numbers of slaves grew to an immense total, so high indeed as to become in the end a turbulent menace to the State. We know, too, that similar conquests at an earlier date had provided Egypt with slave labour enough for the building of the immense temples and pyramids still to be seen in that land. To-day we pursue, apart from some Nazi aberrations during the war, the better path of providing ourselves with mechanical slaves from coal, oil and water power—as perhaps we shall one day from atomic energy. To assess the equivalent manpower thus made available one has to make certain assumptions. Those assumptions may, it is true, be no more than very rough estimates, but at least they should give some indication of the facts. It is a familiar estimate that a man steadily at work can exert one-tenth of a horsepower. If he does this for fifty hours a week he produces each week 5 h.p.-hours of energy, which in a year would correspond to about 180kWh.

We are told that in Canada 42,000 million kWh of electric energy were produced last year, the equivalent on the above showing to the work of no less than 230 million men. These 230 million robots may be looked on as working side by side with the human population of some 10 million, so that in effect each inhabitant has on the average the assistance of twenty-three slaves, or, let us say, of about 100 for every household in the land. It is known that in classical days there were palatial homes in which the number of slaves was still higher, but such must have been rare. Indeed, it is now believed that in the

greatest time of Rome's material prosperity the slave population did not exceed three times that of the freemen. This would give the work of about fifteen slaves for each citizen family. If one brings other countries into comparison with Canada to-day, one has to bear in mind that some use power in electric form more than others. But confining oneself to the electrical figures to begin with, one finds that the electric power consumed in Britain per unit of population is rather less than a quarter of the Canadian figure, and is equivalent therefore to about twenty electric robots per household. Britain, however, consumes a vast deal of power, in addition to its electrical supplies, and if one went so far as to include all that derived from coal, of which the output is about twenty times the Canadian for only five times the population, it would raise the figure for the mechanical assistance per household in Britain to much the same level as in Canada. As one of the political ambitions or dreams of the day is to aim at equalising the standard of living of every country in the world, it is striking to find from a study of the figures that the average ratio for all countries cannot be much above fifteen. This shows what a very great way there is to go before this political ambition can come anywhere near fulfilment.

If, as it seems, there are to-day 100 robots working for each family in the more mechanised countries—seven times as many as Rome ever had—one may well ask what social forms this great advance is taking. Part of it must lie in the far greater speed and frequency of travel, part in better lighting in the house and outside, part in domestic water supplies, and certainly a great gain in the standard of sanitation. To pursue this question fully would be a very suitable task for our social economists, and we commend it to them. For us as engineers, it is abundantly clear that although the more mechanised countries have gone a long way, there is still, even in them, a considerable capacity for further developments on existing lines, apart from tapping the future almost boundless prospect of atomic power, whilst in the world at large there is an immense leeway to be made up before this aspect of the standard of living is even roughly equalised; and an almost limitless field of work for the engineers who will be called on to carry out the task.

Literature

The Scottish Railway Network. By J. F. POWNALL. 10in by 6in, 71 pages. Birmingham: Cotterell and Co.

MANY of us have passed a vacant hour pleasantly in planning, as from an armchair, some new railway route of our fancy. The more intrepid have even essayed the task of rearranging time-tables. But few, we should imagine, would care to commit such efforts to paper. Mr. J. F. Pownall, however, is not content with enunciating a new principle of time-table arrangement;* he has now applied himself to the stupendous task of recasting the entire Scottish railway service to suit his new principle. This provides for the establishment of a series of "hour stations" at distances varying between 44 and 62 miles apart, from each of which express trains shall leave every hour, precisely at the hour, and run to the next hour station in precisely 52 min. A stopping train would follow each express leaving every hour, at 2 min. past the hour, and would occupy 1 h. 44 min. in covering the "hour section." Thus it will be appreciated that by use of the stopping trains and the hour expresses passengers could travel from any station on the network to any other and be assured of a train once an hour, whatever their starting point and destination might be.

From the very outset the scheme is inflexible. No provision is made for the varying requirements of busy or sparsely populated districts, and no provision is possible for dealing with periods of peak traffic, or the duplication of regular trains, as the running of extras would upset the network principle. For a country like Scotland this seems an unpropitious start, even in theory, but when the scheme is examined in detail and one finds that places such as Stirling, Ayr, Falkirk, Hawick, Perth, Motherwell and Pitlochry lie right outside the network, the proposition begins to look still less promising. These important towns would be served by connections, or by the existing lines, which, from the author's statements, would still seem to have to bear the brunt of the traffic. This is not all. In providing the new network it is proposed to construct 420 miles of first-class main line, 375 of which would be in the open and 45 miles in tunnel or on viaduct.

Even considering that the hour stations would primarily be exchange points, their location at places such as Sanquhar, Longtown, Gleneagles, to mention a few of the less populous, with fast trains running for large proportions of their mileage quite contrary to the normal flow of traffic, suggests that the transportation needs of Scotland have been totally disregarded. If traffic requirements have been given scant regard, still less consideration has been given to the economics of the project, and when finally we come to examine the engineering details, in so far as the author has given them a thought, the book reaches new heights of fantasy.

It is not the scheme itself at which we boggle. It would probably do very well in a fully planned community (from which heaven preserve us!), in which the towns were dotted at even intervals over the landscape; and the strict inflexibility of Mr. Pownall's timing rules would doubtless appeal to the hidebound bureaucrats who would revel in the administration of such a system. But the fundamental requirement of modern railway working is the flexibility of control essential to the efficient handling of peak loading and the capacity to deal with quiet periods without waste of locomotive power and staff.

We can foresee two reactions only to this book. The earnest seeker after knowledge and enlightenment will at an early stage probably dispatch it for a "sixer" through the nearest window. The more whimsical will find his early astonishment turning to sheer enjoyment as one breathtaking prospect after another is revealed. Of the latter, we cannot refrain from mentioning two gems of the author's imagination.

On the one-hour section from Wishaw to Ardrossan, cutting athwart the Clyde Valley, it is proposed "to use exceptional grades and to exploit the impetus due to high speeds. The new connection would drop down from Wishaw Hour Station at a grade of about 1 in 30, contouring along the side of a convenient dingle. . . ." It is solemnly proposed to go streaking down one gradient of this inclination and go bucketing up 2 miles of equal ascent, though the author admits that "if by misadventure, the train is caused to stop at the bottom of this dip the locomotive might not be able to take the train up the 1 in 30 grade without assistance, and there would ensue a traffic delay. But such an event should be so rare that this rush grade working should in practice be justifiable."

As a rider to his main scheme, the author proposes to operate expresses non-stop over the 140-odd miles between Glasgow and Inverness in two hours. The route would follow the West Highland line between Crianlarich and Tulloch—presumably realigned!—and then a super-speedway running almost dead straight from Tulloch to Iverness over which speeds of 120 m.p.h. would be run. "Now," continues the author, "the traffic peculiarities of the new Glasgow to Inverness direct line would be interesting. The through expresses would usually not stop at all. For the intermediate deer forest country two trains a day would suffice. But this would be a grand line for recreative travel. We may imagine, say, a large party of skaters in a powerful railcar, bowling along at an unhindered 100 miles an hour, making for some high-level loch. Opposite the loch they detrain on to the side of the line. Having had a very quick run they can enjoy themselves a fair time before the early winter nightfall closes in." Still more interesting, no doubt, would be the capital outlay involved to produce such a route, to cater, be it noted, for so sparse a traffic that private "specials" could make unhindered runs at 100 m.p.h.!

With such a prospect we may conclude by commending to such readers whose fancy lies that way one of the few really amusing books on transport we have ever read.

* "New Railway Network Principles": Cotterell and Co.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

INSTITUTION AMALGAMATION

SIR,—I have been following the correspondence in your columns on Institution Amalgamation with great interest. Personally, I am wholly in favour of any move which would strengthen the status of qualified and professional engineers, provided that such a move is made by the engineers themselves, and not forced upon them by Governmental or other outside pressure. I disagree, however, with the correspondent who suggests that they should unite under the banner of the Institution of Civil Engineers. I have always understood that the splitting away of the Mechanicals and, later, of the Electricals, from the Mechanicals themselves, was mainly due to the failure of the older body in each case to recognise the importance of the newer branch of engineering. My knowledge of past history is, I admit, rather sketchy, but I have lived long enough to see a somewhat similar set of circumstances arise in the case of a still younger branch of engineering, that of Electronics.

In spite of the splash made of its Jubilee Celebration, the Wireless Section of the I.E.E. had to some extent failed to cover adequately the interests of the whole field of electronic

engineering; this ranges, of course, from the internal physics and manufacture of valves and devices to the applicational end, of which "wireless" is only one branch. The Section's papers constituted a relatively small proportion of the I.E.E. *Journal*, and their meetings were located so as to provide virtually no incentive to the provincial to join the Institution. As a result of this, electronic engineers formed themselves into various independent bodies, such as the Electronics Branch of the Institute of Physics, the British Institution of Radio Engineers and the Institution of Electronics. When the status of these bodies reached a level at which they could no longer be ignored, and the attendance at their meetings in many cases exceeded that at the meetings of the I.E.E. Wireless Section, the latter virtually admitted its shortcomings, altered its title to "Radio Section," and issued an appeal to all electronic engineers to fall into its ranks. The answer has been, as I trust it will be in the case of your correspondent's plea, very much in the negative.

Let engineers unite by all means, but do not let the older bodies, who formerly passed over the interests of the younger branches, expect later to absorb them and to reap the benefits of their independent endeavours.

R. G. B. GWYER.

Manchester, June 12th.

THE NATURE OF SUCTION IN NAVIGATION

SIR,—Discussion took place on the effect of suction in the collision between the "Hawke" and "Olympic," but in dealing with this we have to note that the propellers primarily operate by pumping a stream of water from the ship, and from their point of view the forward thrust on the ship is a secondary effect. When the "Hawke" approached the "Olympic" it has been stated that the latter increased the engine speed to get out of the way of the "Hawke." The inertia of the big ship was too great to enable her speed to be instantaneously increased, but there was immediately a greatly increased velocity of the stream of water driven by the propellers, and this caught the "Hawke" and sucked her in to the side of the "Olympic." The collision would probably not have happened if the "Olympic" had slowed down the speed of the engines, as this would have reduced the rush of water and the "Hawke" would have been able to keep clear.

The stranding of the "Queen Elizabeth" involved further questions, as the rush of water from the propellers struck against a mud bank, which caused so much turbulence that the rudder could not control her. As similar accidents have occurred to other ships, it may be well to have tank experiments to see what really happens. It is probable that there also it would have been better to go slow at this point. The whole problem of what happens when a big ship with enormous power is moving in shallow waters with banks near to interfere with the rush of water from the propellers may well be dealt with by careful tank experiments which will help the captain of the ship to avoid accidents in difficult circumstances.

C. TURNBULL.

Newcastle-on-Tyne, May 27th.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS.—The Summer Meeting of the Institution of Heating and Ventilating Engineers is to be held at Eastbourne on Monday, Tuesday and Wednesday, June 23rd, 24th and 25th. The headquarters will be at the Grand Hotel, and the programme includes a technical session on Tuesday morning, June 24th, at 10.15 a.m., when a paper entitled "More Warmth with Less Fuel" will be presented by Mr. A. F. Dufton. A banquet will be held at the Grand Hotel on Tuesday evening, at 7 for 7.30 p.m.

A Study of Relationship in Industry

By J. J. GILLESPIE and A. K. RICE

CHARTS and other forms of graphical representation have become generally accepted as part of the necessary techniques required to study the problems of organisation, and there is no longer any need to emphasise that a good organisation chart helps in the understanding of administrative complexities. A chart of an existing management structure often reveals anomalies of administrative practice and divided authority which have developed unwittingly during the growth of the company, and reorganisation based on a modified chart laying down proper lines of authority and showing correct channels of communication can do much to assist in overcoming difficulties which are almost inevitable when lines, neither of authority nor communication, are well defined; but while an organisation chart can define lines of authority and can lay down proper routes for instructions, information and advice, it cannot show whether the proper lines of authority are being observed or the correct communications being used.

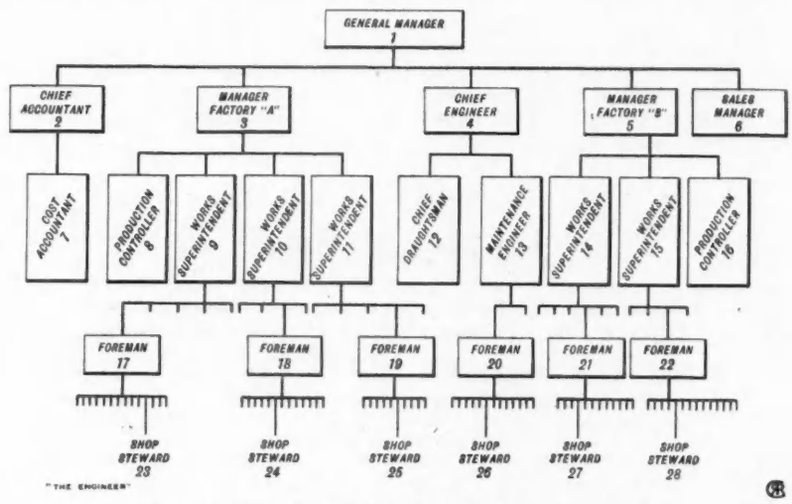


FIG. 1—MANAGEMENT ORGANISATION CHART (ABRIDGED)

An organisation chart shows the structure, but it does not show the life that is going on within the structure. It is misleading, and may even be dangerous, so to concentrate on the structure of an organisation that its texture is overlooked, since the rigidity of the structure may serve to repress the expression of the causes of discord and misunderstanding until it is too late to prevent disruption.

Something more therefore than a chart showing structure is required to give a true picture of the administrative organisation of any institution, and we suggest that there should also be a graphical means of showing the texture of the organisation.

GROUPS AND AGGREGATES

When people combine to engage in a common activity, bonds are formed between them, and the aims of their common activity will best be realised when they work together as a team. It is, however, a misconception to imagine that the placing of people in spatial and status relationship will lead automatically to the formation of a good working group; in other words, to place people together in a factory (spatial relationship) and to define the lines and levels of authority (status relationship) will not necessarily lead to effective working. Unless the people so placed are united in an emotional and mental outlook directed towards the carrying out of their common task, they will remain a collection of individuals torn by difficult internal relationships. They will be an aggregate of individuals rather than a group. An aggregate is marked by egocentric attitudes on the part of those individuals who compose it, whereas in a group the attitudes of those in the group are conditioned to the carrying out of the common task.

This subject is too large to discuss here; suffice to say that the members of an effective group:—

(*a*) Are united in the performance of the group task.

(*b*) Give each other emotional and mental support.

(*c*) Have a real sense of belonging to the group.

When a group of people is so related that the group dynamic supports each member, then, as Moreno* has shown, that group is socially effective.

RELATIONSHIPS

Two people working together have attitudes to each other by reason of their common task, and the addition of a third person means that not only will relationships be formed by the third person with each of the others, but because of those relations, the quality or texture of the earlier relationship between the two may also be changed. In the same way, the addition of a fourth member will not only cause new relationships to be formed, but may also alter the texture of all the existing relationships. The more people there are engaged on the task, the more complex will become the texture of their relationships. Further, the relations between any two people may be reciprocal or non-reciprocal; that is, two people may have the same feeling for each other or one may feel one way to the other and the other have quite a different feeling for the former.

* "Who Shall Survive?" J. L. Moreno, Beacon Hill Publishing Company, New York, 1934.

In order therefore to give graphical representation to the texture of any organisation, it is necessary to illustrate the relationship of each member of the group or aggregate with every other member.

We have divided relationships into four broad classes :—

(1) O relationship. Instinctual and unconscious, found mainly among primitive cultures, where people are not self-conscious, but identify themselves unconsciously with others and with their environment.

(2) I-It relationship. Dictatorship, in which one person uses others merely as instruments to serve his purpose without recognition of their humanity.

(3) I-You relationship. Bargaining, in which a person, or a group, gives only in so far as will result in gain for himself or the group. Advantage to self is the prime consideration.

(4) We relationship. Community and friendship in which the self is subordinated to the common good.

These four broad classes, though defined separately, must overlap to a considerable extent, and we have made, where appropriate, further subdivisions : understanding (conscious appreciation), tolerant (live and let live), and antagonistic, and to denote intensity we have used the adjectives mild, moderate and strong. Thus a relationship might be defined as "reciprocal, moderate antagonistic I-You" or "strong We," &c.

The work of collecting data for a study of the relationships of any group is clearly never easy, and while it is possible to observe the overt personal relations in an operating group, in a management group the formal relations of management structure may so confuse the picture that it becomes exceedingly difficult to detect even true overt personal feelings and attitudes.

One may gradually gain impressions during the course of one's work, one may observe attitudes when difficult situations arise, and in certain circumstances it is possible to organise interviews especially for the purpose of a survey, but undoubtedly the best method is the positive sociometric method used by Moreno in America.† In this method members of groups were asked to state whom they would like to have for associates, subordinates and supervisors.

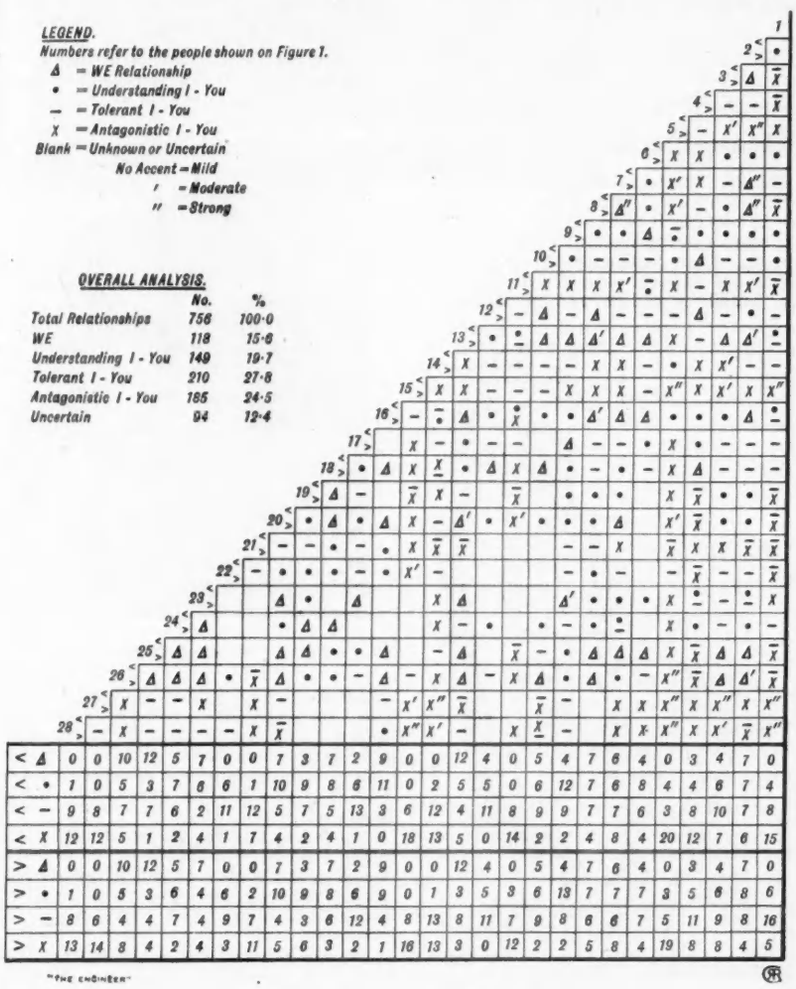

LEGEND.
Numbers refer to the people shown on Figure 1.
Δ = WE Relationship
• = Understanding I - You
– = Tolerant I - You
X = Antagonistic I - You
Blank = Unknown or Uncertain
No Accent = Mild
′ = Moderate
″ = Strong
OVERALL ANALYSIS.
No. %
Total Relationships 756 100·0
WE 118 15·6
Understanding I - You 149 19·7
Tolerant I - You 210 27·8
Antagonistic I - You 185 24·5
Uncertain 94 12·4

FIG. 2—RELATIONSHIPS CHART

TO READ THE CHART.—To find the relationship between any two people read across and down. The arrow head pointing outwards (upper) is the attitude of others to the numbered person, the arrow head pointing inwards (lower) is the attitude of the numbered person to others ; *e.g.*, attitude of 8 to 1 is mild antagonistic I-You ; 1 to 8 is tolerant I-You ; relationship between 2 and 7 is strong reciprocal WE ; between 26 and 5 is strong reciprocal antagonistic I-You. (Where the relationship is reciprocal only one symbol is given.)

CHART OF RELATIONSHIPS

The definitions of relationships and the form of chart described here are based on those developed by J. J. Gillespie some eight years ago.‡

The chart is designed so that the relationships between any members of a group or aggregate may be read both ways ; that is, the feelings of each member for all other members, and their feelings for him are both shown, and the texture of the total relationship pattern can be assessed by a summation of all relationships.

Fig. 1 shows the management organisation of a company employing approximately 1000 workers in two factories situated near to each other. The accounting, engineering and sales functions were common to both factories and one works council contained representatives for both works.

Fig. 2 shows the texture of the organisation ; that is, the relationships lying behind the management structure. Fig. 1 shows management status, no more, and could be very misleading if it were taken to reflect anything other than formal structural relationship.

A complete relationships chart would include everybody in the organsation. Here for illustration purposes the attitudes of the workers have been represented by the attitudes of some of their elected representatives, a rough, but we believe a justifiable, sampling, and for the sake of brevity sample foremen only have been shown.

A cursory glance will show that the organisation structure as laid down in Fig. 1 is not reflected by the texture, and that the people in these factories are definitely an aggregate and not a group.

ANALYSIS OF RELATIONSHIPS CHART

At the bottom of the chart in Fig. 2 is shown the sum of the attitudes of others to each person, and the sum of the attitudes of each person to others.

For example, No. 4 (chief engineer) has a friendly relationship with three people, is understood by four, tolerated by eight, and disliked by twelve, while he understands five, tolerates eleven and dislikes eight.

The dominants in the pattern illustrated are Nos. 1 and 5. No. 1 at the head has poor or bad relations with most others of the aggregate, while No. 5 and the members of his department 14, 15, collect between them fifty-one of the antagonistic attitudes. The two shop stewards in the same factory, Nos. 27 and 28, collect a further twenty-four antagonistic attitudes, and are both in strong antagonistic relation to 14, 15 and 5, and at the same time are in either antagonistic or only tolerant relationships with their colleagues and each other ; 14 and 15 together collect thirty-one antagonistic relationships and at the same time are antagonistic to each other, and 15 has strong antagonistic relations with 5, his superior. A chaotic pattern!

For thorough analysis further sectional charts were drawn of top management 1–6 inclusive ; of the management of factory A, 1, 3, 8, 9, 10, 11 ; of the department controlled by 9 ; and so on.

The analysis of a relationships chart is a long and arduous task, and in every analysis the first essential is to look for the outstanding personalities who dominate the situation. There may be many antagonisms or tolerations which are antagonistic or tolerant only because of the influence of the dominants. Such relationships may be improved by a change in the dominants.

CONCLUSION

The value of good management is becoming increasingly recognised and the importance of good human relations in industry is now receiving some attention, but there is a danger that attention will be directed only

† "Who Shall Survive ?" J. L. Moreno, Beacon Hill Publishing Company, New York, 1934.

‡ "Engineering Reorganisation," James J. Gillespie, Isaac Pitman and Sons, London, 1938.

to the lower ranks of supervision. The burden of much present thinking is that provided the junior supervisors are good leaders all will be well, but as can be seen in the small study analysed here, good junior supervisors are powerless if relationships at the top are bad.

The study of the structure and texture of industrial relationships can contribute to an assessment of an industrial situation; the improvement of relationships in the working group, in the management group and between the two groups can contribute to the solution of the problems of production. But it is important to recognise that human relations form only a part of the total pattern of the industrial background. The culture in which we live must determine the final pattern of industry, and our present culture is acquisitive and competitive, and we are therefore conditioned to bargaining relationships in which self advantage and personal gain are the dominating motives. With guaranteed full employment, social security and better education, with primary wants satisfied, competition and acquisition will be less powerful incentives and other motives must operate if we are to increase or even to maintain our efficiency of production. Whatever the future structure of industrial management organisation, the dynamic study of relationships will be necessary and instructive.

The Institution of Gas Engineers

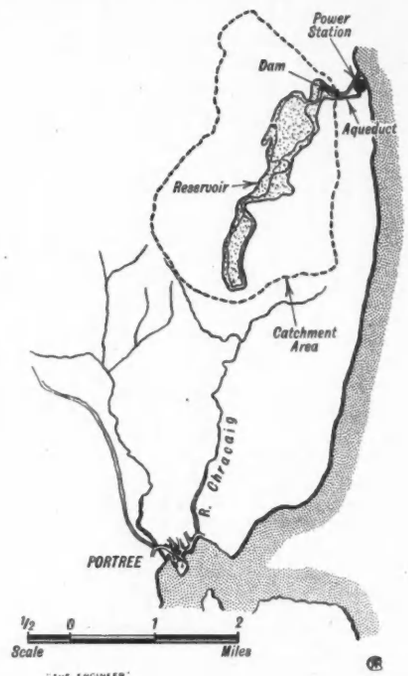
THE 84th Annual General Meeting of The Institution of Gas Engineers, which was held in Birmingham from June 3 to 6, 1947, was attended by over 1200 gas engineers and visitors, under the presidency of Mr. George C. Pearson, chief engineer of the City of Birmingham Gas Department. The meeting was attended by official delegates from the Gas Associations of Belgium, Czechoslovakia, Denmark, France, Holland, Norway and Switzerland, as well as by official representatives of Dominion and Allied Governments and of the Control Commission in the British Zone of Germany.

Following the Presidential Address, six papers were presented and discussed. The first, "Restoration and Control of the Gas Industry in the British Zone of Germany, 1945–47," by H. D. Greenwood, gave a detailed account of the gradual restoration of a gas supply in the British Zone of Germany from the entry of the Allied forces in 1945 to the present time. The second, entitled "Some Aspects of Gas Measurement," by W. L. S. Spinks and A. E. Mason, City of Birmingham Gas Department, presented a critical description of large and small gas apparatus for measuring gas, and of their testing. The third paper, "The High Pressure Gasholder," by M. Noone and A. G. Grant, presented technical data and recommendations on the design and construction of large vessels for storing town gas under pressure. The next paper, "The Control of Chemical Reactions on a Large Scale," by Dr. J. G. King of the Gas Research Board, reviewed "fluidised" reaction systems as used in the oil industry and suggestions for their application to gas industry processes. In the fifth paper, "Electricity in the Gas Industry," by G. M. Rimmer, methods of generating and utilising electricity at gas works were discussed, together with control and instrumentation, safety precautions, maintenance of plant and notes on electrolytic corrosion. The final paper, "The Education, Recruitment and Training of Gas Engineers," by Professor Stacey G. Ward, University of Birmingham, made suggestions for the closer collaboration between the universities and industry, with particular reference to the supply of trained technical personnel for the gas industry.

The meeting included visits to several of the works of the City of Birmingham Gas Department, to the works and laboratories of Radiation, Limited, and to the three following large industrial users of gas: the Longbridge Works of the Austin Motor Company, Limited; the Fort Dunlop Works of the Dunlop Rubber Company, Limited, and the Witton Engineering Works of the General Electric Company. At the conclusion of the meeting, Mr. Pearson relinquished the presidential chair. He is succeeded by Dr. Harold Hartley, technical director of Radiation, Limited. Dr. Hartley has been associated with Radiation, Limited, since 1912. He is also the present president of the Cast Iron Research Association.

North of Scotland, Storr Lochs Hydro-Electric Scheme

THE North of Scotland Hydro-Electric Board last week gave some details of the Storr Lochs scheme in the Island of Skye, the first hydro-electric scheme in the Western Isles. The project, known as Constructional Scheme No. 13, will cost about £247,000 and will be developed in two stages. Initially it will have an annual output



MAP OF STORR LOCHS SCHEME

of 1¾ million units and, finally, an annual output of 5½ million units of electricity to serve the 10,500 people of Skye and provide opportunity for agriculture and industrial development.

Electricity produced by the Storr Lochs scheme will be distributed by the Board's distribution scheme for Skye, published in 1946, which by means of 178 miles of high-voltage and 151 miles of low-voltage distribution lines will make electricity available to over 70 per cent of the population of this island (647 square miles).

The site of the project is a valley, south of the precipice of Storr, between Portree and Staffin. A gravity dam, 170ft long and 36ft high, will be constructed at the north end of Loch Leathan. The dam will raise Loch Leathan almost to the same level as Loch Fada, the southern loch in the valley, providing about 87 million cubic feet storage. The catchment area is about 5 square miles and the average rainfall 59in.

A pipe line 2800ft long will carry the water from the loch to the generating station, which will be constructed on the shore near the mouth of the Bearreraig River. The final stage of the work will involve the construction of a second pipe line to feed the turbines, which will operate at a gross head of 440ft. The generating station will consist initially of one 800-kW set, and the second stage will increase the total installed capacity of the station to 2400kW.

An Improved Magnifying Instrument

A NEW model of the "Speetool-Gordon Magnascope," an instrument for examining components under magnification with a brilliant beam of light directed against the work piece, has been introduced by Speed Tools, Ltd., Vereker Buildings, Greese Street, London, W.1.

The new instrument has a wider field of vision by reason of the 3½in by 2½in rectangular lens,

"MAGNASCOPE"

which can be supplied optionally to the circular lens. Its magnification is about 3½ times, and a system of ventilation keeps the hood cool, even when using a standard 60-W bulb. A reflecting unit in the instrument is so designed that a 15-W bulb will give efficient illumination for most classes of work.

The instrument can either be mounted on a plain stand in order that it can be moved on a bench as and when required, or it can be fitted to a plain stand having three fixing holes, as illustrated above, for permanent bench mounting.

We are informed that a new development of this instrument, known as the "Autopoise," will shortly become available. In this design the hood is carried in extended twin arms, counterbalanced for free adjustment, in order that the device can be quickly brought into any desired position.

THE P. & O. LINER "STRATHEDEN."—The departure this month of the P. & O. 23,700-ton liner "Stratheden" for Australia on her first post-war voyage as a regular passenger liner makes an interesting contrast with the maiden voyage of the "Indus" in June, 1847, exactly a hundred years ago. The "Indus" which was regarded as the pride of the P. & O. fleet of those days, had a tonnage of 1782 and carried a cargo of 300 tons. The engines of 450 h.p. gave her a speed of 10 knots, and she was barquentine-rigged. Calling at Gibraltar and Malta, she went to Alexandria, where her passengers and cargo were landed and transported across the isthmus of Suez, since the Canal was not then in existence. At Suez another P. & O. ship, the "Bentinck," was waiting to carry on with the next stage of the voyage to Aden, Point de Galle (Ceylon), Madras and Calcutta. At Point de Galle there was a further transhipment for Penang, Singapore and Hong Kong by the P. & O. "Pekin," another paddle steamer of 1112 tons. The "Indus" was lengthened in 1852 to increase her capacity. After catching fire in dock she was given new engines of 650 h.p. A year later she carried the first Australian mails to go *vid* Suez.

"ELECTROGYRO" FLY-WHEEL PROPULSION UNIT—OERLIKON

"Electrogyro" Fly-wheel Propulsion Unit

In last week's issue on page 524 we gave a brief description of a vehicle which is propelled experimentally by a new form of self-contained power unit known by the title of "Electrogyro." To recapitulate, this system consists essentially of a high-speed fly-wheel (running in an atmosphere of hydrogen to reduce frictional losses), which is directly coupled to the rotor of a three-phase squirrel-cage machine. As the fly-wheel slows down its kinetic energy is converted into electrical energy, which is used by driving motors to propel the vehicle. At convenient halting places, energy is restored to the fly-wheel by plugging in the three-phase machine to run as a motor on the normal distribution mains supply.

Since our previous description was published we have received some further photographs illustrating the "Electrogyro" unit, which was manufactured by Oerlikon, Ltd., of Zürich-Oerlikon, Switzerland. The left-hand engraving, above, shows the Ni-Cr steel fly-wheel and the squirrel-cage rotor lifted away from the lower half of the casing, so as to show the ball races of the bottom bearing. The second engraving gives a general view of the assembled unit showing that the upper half of the fabricated casing forms a common housing for the fly-wheel and the squirrel-cage machine.

A Work Locator for Second Operation Machining

When performing second operation work on a batch of components, such as screw threads, relieved taps, gear wheels, &c., a fair amount of time is wasted by the operator in setting successive pieces of work in the machine, with the teeth or threads in true relationship to the tool or grinding wheel. In order to avoid this waste of time in "picking up" the form in a number of similar components, the Coventry Gauge and Tool Company, Ltd., Coventry, has developed the "Matrix" work locator.

The instrument consists essentially of a round bed with a fixed headstock and a moveable tailstock having a spring-loaded centre. A swinging arm mounted on the bed between the head and tailstock carries a spring-loaded indicator slide in which is fitted a stylus and a dial indicator. The stylus is interchangeable and can be selected to suit the profile and type of work being set.

In the photograph we reproduce, the instrument is shown as adapted for setting roughed-out threaded work prior to finish grinding. The workpiece is mounted between the centres, with its carrier slackened. The swinging arm is then adjusted with its stylus bearing on the component and the dial indicator registering a light pressure and set to zero. With the arm locked in this position, the workpiece is then rotated and, at the point of reversal of the indicator needle, the driving face of the carrier is pressed firmly against the locating peg in the headstock and locked. Both component and carrier are then removed from the locator and transferred to the thread-grinding machine, which is set to this initial component. The

Pre-Setting a Threaded Component

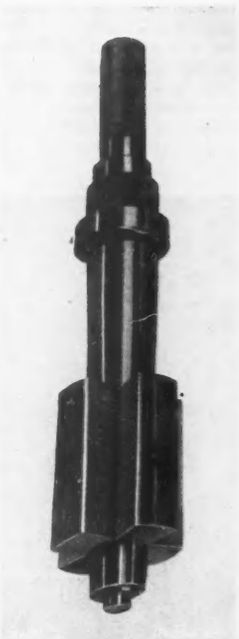
machine setting is retained for the remainder of the batch of work and each successive component is preset relatively to its carrier on the locator to correspond to the setting of the original piece.

The presetting of gears on mandrels in relation to their carriers is carried out in a similar manner to that of threaded work, except that a stylus comforming to the circular pitch of the gear is used.

An Adjustable Plug Gauge

A new adjustable plug gauge, which has been developed by Manvers Adjustable Gauges, Ltd., 2, Central Buildings, London Road, Bognor Regis, has a useful range of application in precision tool work and machining.

We reproduce a photograph of this gauge, which consists essentially of a hollow tapered body, in the lower part of which are four slots cut at 90 deg. to each other. Four gauging blocks or elements are slidably mounted in these slots and are securely retained in position by loaded springs. The blocks are coupled to move as a single element along the slots by the turning of a knurled collar on the shank above the body. It will be appreciated that as the blocks are moved upwards or downwards on the tapered body their outside diameter increases or decreases accordingly. Once the required



An Adjustable Plug Gauge

setting is obtained the blocks are locked firmly in position by the screwing down of the knurled handle above the collar.

Not only can this gauge be used as a standard plug gauge when set to any required dimension, but it can also be used by machinists in order to measure the diameter of holes to a high degree of precision. For this purpose the gauge is introduced into the hole, the blocks are then adjusted to a snug fit and locked. The gauge can then be withdrawn completely or partially from the component for the measurement to be taken across the blocks by means of a micrometer or vernier.

The gauge is also designed to facilitate the rapid and accurate setting and checking of hole centre distances. For this purpose a 1in diameter collar at the top of the body and the periphery of the gauge blocks are ground and lapped on the same setting. The two members are concentric at any stage of adjustment and the

centre line of the disc is always the same as that of the hole being checked.

The gauge can also be adapted for the accurate measurement of internal threads by using it in conjunction with wires of the appropriate size, which are curved to conform to the internal diameter.

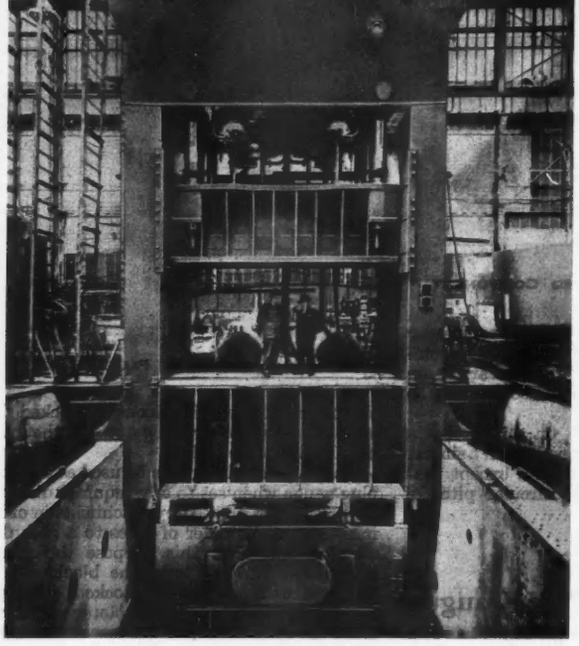
We are informed that these gauges are made in a range of sizes to cover diameters from 0·750in to 2·550in in increments of 0·20in.

A Large Crankless Press

THE largest crankless, triple-action "Clearing" press to be built in this country was recently completed at the Elswick works of Vickers-Armstrongs, Ltd., to the order of Rootes Securities, Ltd. This press has been designed to produce the side of a motor-car body or the single-piece roof and back of a streamlined car. It will in one operation form the shape and pierce the windows from sheets of steel as fast as they can be fed into the machine.

The press has a capacity of 1500 tons at a stroke and can be worked at 300 strokes per hour (triple-action) and over 400 strokes per hour (double-action). It has three separate mechanisms, which impart motion to three separate slides. A blankholder slide first clamps the steel sheet; the inner slide then presses it into shape and finally the lower slide moves upwards, carrying piercing tools in an inverted punch for an additional drawing operation.

The machine is of all-welded steel construction, its crowns, slides and beds being designed for a maximum deflection of only 0·001in per foot of length when the press is running at full capacity. Sheets up to 15ft in length are admitted between the uprights, the width across the blankholder being 8ft.



CRANKLESS TRIPLE ACTION PRESS

The main slide has a stroke of 40in, whilst the blankholder slide and the lower slide have strokes of 32in and 10in respectively. Without its tools and dies the press weighs some 320 tons.

The class of work for which this type of machine is intended frequently calls for deep draws on one side of the work, sloping to shallow curves on the other side. In order to eliminate the deflection of beds and slides as a result of this uneven loading, the pressure is applied at four points on the slide and a special guide arrangement has been adopted. Each pressure point on the slide is actuated individually through a combination eccentric gear unit drive, or direct-eccentric drive, as it is more commonly known, mounted directly overhead in the press crown. In each unit the eccentric is formed integrally with its driving gear, which rotates in bearings on a short shaft and is driven by a main pinion. A strap from the eccentric transmits motion through a plunger to the slide below. The plungers are guided in long bronze bushes in the lower side of the press crown to avoid any possibility of their tilting. The blankholder has four individually adjustable jibs and the inner slide is bronze lined and guided inside the blankholder.

The compressed air operated clutch and brake mechanism of the press are mounted on a common shaft, and they form a compact interlocked unit. Clutch and brake relining is facilitated by the mounting of the linings in segments, which can be withdrawn and replaced without disturbing other parts of the mechanism. The clutch is push button controlled through solenoid valves and can be set to give continuous running, single-stroke operation or "inching" for setting purposes.

The photograph which we reproduce shows the new press in course of erection. We are informed that a similar double-action press of 575 tons capacity is now being built at the Vickers-Armstrongs works.

New Fruit and Vegetable Vans for L.M.S.

WHEN conditions permit, the London, Midland and Scottish Railway Company proposes to build 200 new ventilated vans for the transport of fruit and vegetables from the Worcestershire fruit and vegetable growing district centred on Evesham to Midland and Northern markets. This decision follows experience gained from the use of six experimental vehicles which have been in service since April, 1946. These experimental vans were constructed after research by the company into the transport requirements of agriculture, in the course of which helpful suggestions were received from representatives of the Worcestershire fruit-growing industry.

The analysis of the evidence collated during this investigation led to the conclusion that improved conditions of transport for fruit and vegetables would be afforded if certain important modifications were made in the design of the vans allocated to the traffic; these changes included the provision of improved ventilation by forced draught, a double roof for insulation, and four permanently attached wire mesh shelves.

To enable practical tests to be made, six L.M.S. standard goods vans were converted and equipped on the lines suggested.

In the experimental vans eight torpedo type ventilators are fitted to the double roof, whilst in the sides and ends six ventilating grilles are arranged, one at each end and two along each side. The four side grilles are fed by eight air scoops, four on each side of the vans.

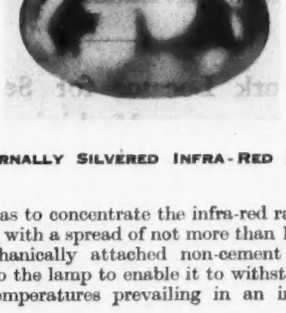
Four shelves, with angle iron frames and having wire mesh bases, are hinged to the van sides, 3ft 9in from the floor and supported by chains. The approximate loading capacity of each shelf is 7½ cwt and each will accommodate forty 12-lb chips of fruit.

The summer of 1946 did not produce periods of prolonged hot weather, and in consequence the new ventilation and insulation system could not be fully tested, but sufficient evidence was forthcoming to prove its value, particularly in the prevention of "sweating" in bagged and crated vegetables. The shelving was found to help considerably in the loading and segregation of small quantities of produce for different consignees, and in separately loading different varieties of fruit and vegetables. An increase by an average of about 10 cwt in the load carried per vehicle was brought about by the use of the shelves. It is stated that reports received have indicated that fruit and vegetables conveyed in the experimental vans have been delivered at destination points in prime condition.

Internally Silvered Infra-red Lamp

THE introduction of an internally silvered infra-red lamp is an important event in the application of infra-red energy to industrial processes, such as drying and baking. This lamp, which was exhibited for the first time at the recent British Industries Fair, is now being manufactured by the British Thomson-Houston Company, Ltd.

As illustrated herewith, the new "Mazda" 250-W infra-red lamp has a parabolic-shaped bulb with a satin-frosted crown. The lower half of the inside surface of the bulb is silvered to form an internal reflector, which is so contoured as to concentrate the infra-red rays into a beam with a spread of not more than 120 deg. A mechanically attached non-cement cap is fitted to the lamp to enable it to withstand the high temperatures prevailing in an infra-red oven.



INTERNALLY SILVERED INFRA-RED LAMP

Since the new lamp forms a self-contained unit, all external reflectors can be dispensed with and the space so saved can be used to mount the lamps closer together and to intensify the heat concentration obtainable from a light and compact arrangement of lamps. Maintenance is reduced to the simple task of cleaning the outside of the bulb. Owing to the low operating temperature of the filament the reflector is subject to very little blackening, and it is claimed that the reflector maintains its initial efficiency almost to the end of the lamp's life. Busbar assemblies have been designed for use with the new lamps and these can be arranged to form contours suitable for the various applications of infra-red baking and drying.

Canadian Engineering Notes

Orders for C.N.R. Locomotives

Bringing the total number of diesel-electric locomotives ordered by the Canadian National Railways so far this year to forty-eight, the company recently announced the award of two contracts for the construction of twenty-eight additional units. Eighteen will be built by the Electro-Motive Division of General Motors Corporation at La Grange, Ill., U.S.A., and the others by the American Locomotive Company at Schenectady, N.Y. The previous orders were for the construction of eighteen diesel locomotives by the Canadian Locomotive Company, Ltd., at Kingston, Ontario, and two by the General Electric Company at Erie, Penn. The eighteen E.M.C. shunting locomotives will be powered by twelve-cylinder, two-cycle, 1000 h.p. diesel-electric equipment. Connected to a main generator, they furnish power to four traction motors, each operating a pair of 40in drivers. Overall the locomotives will be 44ft 5in long and will each weigh 125 tons. They will be equipped with recently developed air brakes, a motor cooling system, a new wheel slip relay device to reduce slipping, a cab heating system for the comfort of the crew under Canadian winter-time conditions and with a 600-gallon fuel tank. Their maximum speed will be 60 m.p.h.

New Power Projects

The provinces of Ontario and Quebec have reached an agreement for the joint development of new power sites on the Ottawa River at Chenaux and Cave Rapids, which will result in development of about 200,000 h.p. of electrical energy. Cave Rapids is 6 miles above Mattawa, and about 200 miles north of Ottawa. Chenaux Rapids are farther north. The Ottawa River forms the boundary line between the two provinces and the agreement calls for each province to employ its own workmen on their respective sides of the river. Actual construction and development will be under direction of the Ontario Hydro-Electric Power Commission, in consultation with the Quebec Hydro Commission. Development of these additional sites on the Ottawa River is part of the 200 million dollars five-year post-war programme of expansion and development. The largest project of the series is the development at Des Joachims. When completed in 1949, this site will furnish more than 400,000 h.p., to be used in the Hydro's Southern Ontario system, and its cost has been estimated at 50 million dollars.

Research Centre

Canada's atomic energy plant at Chalk River, Ontario, is being developed into a research centre for universities. Scientists from universities in Canada, the British Empire and elsewhere will be instructed at Chalk River on advances in atomic work and radioactivity. Eventual discoveries in the field of medicine are looked for from the plant, though at this stage the research work is just getting under way.

Gas Dynamics Research

All research functions of the former Crown Corporation, Turbo Research, Ltd., have been taken over by the newly formed Gas Dynamic Section of the National Research Council. Housed in the Council's Montreal Road laboratories, the new section will investigate problems connected with jet propulsion, gas turbines, heat exchangers, &c. Gas dynamics research will be supervised by D. G. Samaras, a Greek engineer who has studied extensively in Europe. The new section has inherited two cold-weather test sets, constructed by Turbo Research at Stevenson Field, Winnipeg. One of these has been shipped to Ottawa for installation in the Montreal Road laboratory; the other will remain at Winnipeg at least until definite plans are made for its use.

Complex Rail Problems

Addressing the annual meeting of the Halifax Board of Trade recently, Mr. R. C. Vaughan, chairman and president of the Canadian National Railways, said Canada's railway transportation industry is faced with problems of a complexity, perplexity, and variety beyond memory. Because the change-over from war to peace had altered the nature of the commodities being handled and affected the urgency for handling them, he said, the average tonnage loaded per freight wagon had decreased. The average length on haul had also shortened, but the demand for box and refrigerator wagons had not lessened. The problem, he said, became even more complicated through the fact that equipment could not be taken out of service for repairs without reducing the quantity available to meet almost maximum demands. To relieve this shortage the Canadian National Railways had approved the purchase of 3000 units of various types of freight equipment, but the materials needed for this purpose were also the kind greatly in demand for the general reconversion programme, and there were no means of knowing when delivery would be obtained. Mr. Vaughan said there had been an increase of 48 per cent in the average annual earnings per employee since 1939, while for the whole range of railway purchases the average cost of materials and supplies now is 1·42 dollars a unit, compared with one dollar in 1939.

Public Works

Details of an important phase of government planning to prevent any future depression were given recently in a paper presented to the Peterborough branch of the Engineering Institute of Canada by Mr. H. W. Lea, co-ordinator of public projects, Department of Reconstruction and Supply. Mr. Lea disclosed that within the last six months a reserve of desirable public projects had been built up and that when any measure of recession in employment became apparent, selection would be made from this reserve for immediate action. The reserve, including projects now in process of study by the public projects branch, at present consists of ninety-six items, the estimated cost of which amounts to 35 million dollars. The potential reserve, embracing items which had been studied and on which there was agreement that future construction would be in the national interest as a responsibility of the federal authorities, numbered close to 1000 projects, which would require an approximate expenditure of at least 700 million dollars to complete. The national reserve of public projects is made up of a register of proposed construction for which detailed plans, specifications and estimates have been prepared and for which sites are available.

New Passenger Ship

Order for a new 5000-ton Canadian National passenger steamship has been given to the Burrard Dry Dock Company, of Vancouver, in accordance with the policy to purchase in Canada, wherever possible. The steamship will replace the "Prince George" for use in Pacific Coast and Alaska service and is the largest passenger boat to be built on the Pacific coast. To be built at a cost of 3,000,000 dollars, it is scheduled to enter service in 1948. The vessel will have an overall length of 350ft, a breadth of 52ft, and a speed of 18 knots. There will be accommodation for 322 passengers, all in outside cabins, and 50,000 cubic feet of cargo space, of which 5000 will be refrigerated.

Quality Control Methods

A Special Committee has been established by the National Research Council to promote the application of mathematical methods in the treatment of certain industrial production problems. Industries have achieved marked success with sampling inspection schemes which are used by manufacturers to control the quality or dimensions of mass-produced articles through the testing of a small fraction of the total output. Purchasers have also put acceptance testing on an actuarial basis. Sample surveys of consumer requirements, welfare conditions, &c., provide data that can be used for a variety of purposes. In the experimental sciences, research workers find it necessary to make statistical analyses of their data for the proper planning and analysis of tests which must be undertaken with variable materials. The special techniques required in this comparatively new work are based on the mathematical theory of probability and special skills are required in the adaptation of these techniques for various purposes. Members of the Council committee include specialists in statistical quality control procedures, in sampling surveys, in the design of experiments, and in the statistical study of variation. The Committee will assist Canadian users of mathematical statistical methods by consultation and advice respecting specific technical problems, will support research in this field by qualified workers, and will provide a means of liaison with technical groups in Canada and abroad.

The Birthday Honours

THE King's Birthday Honours List was published on Thursday morning, June 12th, and the following are amongst the awards made to engineers and scientists. The Order of Knight Bachelor is conferred upon Mr. J. S. Boyd, Permanent Vice-President of the Shipbuilding Employers' Federation; Mr. Ralph Freeman, M.Inst.C.E., of Freeman, Fox and Partners, consulting engineers; Major H. R. Kilner, deputy chairman and managing director of Vickers Armstrongs, Ltd.; Dr. Andrew McCance, F.R.S., Member of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research; Mr. G. S. Maginness, President of the British Employers' Confederation; and Mr. C. J. Mole, Director General of Works, Ministry of Works. In the Foreign Office List, the K.B.E. is conferred upon the Hon. Cecil J. H. Campbell, managing director of Marconi Radio Telegraph Company, of Egypt, and Mr. H. H. Grindley, director and general manager of the Central Uruguayan Railway Company, becomes C.B.E. In the Order of the Bath, Engineer-Rear-Admiral C. H. Nicholson, Major-General B. E. C. Dixon, and Major-General A. W. Sproull, become C.B. (Military Division), while in the Civil Division the C.B. is conferred upon Colonel Sir James Lithgow, chairman of William Beardmore and Co., Ltd., and Mr. E. T. Paris, Principal Director of Scientific Research (Defence), Ministry of Supply. Appointments to the Royal Victorian Order include officers of H.M.S. "Vanguard," among them being Engineer-Commander L. A. B. Peile, R.N., who becomes M.V.O. In the Order of the Star of India, the C.S.I. is awarded to Mr. R. McIntosh, chief engineer of the Pubic Works Department, Madras. The C.M.G. in the Order of St. Michael and St. George is conferred upon Mr. H. Basten, chairman and general manager, Singapore and Penang Harbour Boards and Major C. R. Turner, lately general manager of the Gold Coast Railway. In the Order of the British Empire, awards in the Military Division include the C.B.E. to Engineer-Captain C. J. Gray, R.N., retired. In the Civilian Awards, Miss Caroline Haslett becomes D.B.E. The Honour of C.B.E. is also conferred upon Mr. J. E. C. Bailey, managing director, Baird and Tatlock, Ltd.; Mr. Cecil Bentham, M.Inst.C.E., engineering consultant to the Admiralty; Mr. W. Newton Booth, M.I.Mech.E., Chief Mechanical Engineer, Royal Ordnance Factories, Woolwich; Mr. O. F. Brown, Assistant Secretary, D.S.I.R.; Alderman C. B. Chartres, M.I.E.E., Vice-Chairman of the Agricultural Machinery Development Board; Dr. T. P. Colclough; Mr. E. W. L. Field, M.I.Mech.E., director of the N.W. Engineering Trades Employers' Association; Mr. H. L. Kirke, M.I.E.E., head of the Research Department of the B.B.C.; Mr. Rowland Nicholas, M.Inst.C.E., city surveyor and engineer, Manchester; Mr. G. F. Silley, shipyard manager, R. and H. Green and Silley Weir, Ltd.; Mr. C. C. Walker, F.R.Ae.S., director and chief engineer, de Havilland Aircraft Company, Ltd.; and Mr. W. L. Whitaker, superintendent, Operative Department of the Royal Mint.

Industrial and Labour Notes

The Regional Boards for Industry

A talk on the Regional Boards for Industry was given recently to the Governing Council of the British Engineers' Association by Mr. George Dickson. Mr. Dickson, who is the Acting Chairman of the London and South-Eastern Regional Board, first of all recalled the setting up of the Regional Boards, or Area Boards as they were then called, and explained how they were instrumental in facilitating the war effort of industry in general. He then spoke of the decision, taken in November, 1945, to continue the regional organisation for industry and explained the peacetime functions of the Boards.

These functions, Mr. Dickson said, were to advise Ministers and their Departments upon industrial conditions and upon steps which might be necessary to bring the resources of capacity or labour into fuller use; to keep in close touch with the work of Government Departments in the regions, in so far as such work dealt with industrial questions; to keep local industry advised of Government policy in relation to industry and to keep headquarters informed of the views of local industry; and to deal with any other questions affecting production which might be referred to the Regional Boards and which were suitable for local treatment, excluding, of course, negotiations covering wages and conditions.

Mr. Dickson went on to suggest that nowadays we were not making our peacetime common objective clear. We were forgetting, he thought, that the whole nation before the war had almost unanimously agreed that, above everything else, we wanted to secure in these islands "democratic full employment under fair wages and conditions for everyone able and willing to work." We had forgotten that "full employment" was an objective to be fought for, not a privilege to be granted by any benevolent Government, for no democratic Government could guarantee full employment. The people must work for it with all their might, but, Mr. Dickson emphasised, they must be convinced, as they were during the war, that "democratic full employment under fair wages and conditions" was the highest common factor of common interest for everyone in the nation. Our fault to-day was the too-easy assumption that "full employment" would be assured by tricks of trade which politicians of this colour or that might or might not be able to apply.

Without a clearly understood and firmly upheld common objective, the Regional Boards for Industry would never again be very useful, for, Mr. Dickson asserted, they would have nothing by which to measure results and nothing by which to measure conduct and efficiency. The first thing to be done to put the matter right was to insist at every possible opportunity that our over-riding commonly agreed national and local objective was "democratic full employment under fair wages and conditions for everyone able and willing to work." We must be determined to guide all our actions and all our thoughts to that end.

Pilot Census of Distribution

The Board of Trade is preparing to hold a pilot census of distribution in the early part of 1948 in respect of the year 1947. It may be recalled that this pilot census was to have been held this year, but was postponed. The census will cover all retailers, wholesalers, caterers, motor traders and service traders whose businesses are situated in certain areas of the country. These areas, it is stated, have been carefully selected in order to obtain experience of the problems which may arise in different parts of the country.

The forms for the pilot census will be sent to traders in the selected areas for completion in the early part of 1948, and some of the questions will ask for information in respect of the week ending June 21, 1947. The details required include numbers of full-time employees, male and female, and numbers of part-time employees; the total wages payable to each group, *i.e.*, those under and those over eighteen; the number of employees normally earning over £10 a week and the total paid to them for the week; and the number and type of delivery vehicles in use during the week and the number of staff employed on delivery.

This pilot census applies only to traders in the selected areas, which will be advertised as fully as possible. The chief object, it is explained, is to help the Board of Trade to decide upon the most effective, practicable and economical methods of holding the first full Census of Distribution now planned to take place in 1950 in respect of the year 1949. All the traders concerned are therefore asked to assist by noting the information which will be required for this week in June, and keeping it ready at hand until it is wanted for completing the pilot census forms.

Iron and Steel Production

Iron and steel production in the United Kingdom continued to improve during the month of May, although the effect of recent fuel limitations may be seen when the figures are compared with those for the corresponding month of 1946. The weekly average output of pig iron during May was 141,900 tons, representing an annual rate of 7,378,000 tons. The annual rate of production in April was 7,238,000 tons and in May, 1946, 7,860,000 tons. The weekly average output of steel ingots and castings was 243,900 tons in May showing an annual rate of 12,684,000 tons. In April the annual rate was 12,294,000 tons and in May last year 13,619,000 tons.

Coal Imports from the U.S.A.

Replying to questions in Parliament on Thursday of last week, Mr. Shinwell, the Minister of Fuel and Power, announced that as a result of the recent application made by the United Kingdom to the European Coal Organisation, an allocation of American coal had been made to this country for the third quarter of 1947. The allocation, which amounted to 600,000 tons for the quarter, was contingent upon the total U.S.A. availability of export coal to Europe attaining and exceeding 3,000,000 tons a month. Provision had also been made by the European Coal Organisation whereby, in certain circumstances, the United Kingdom would be entitled to secure tonnages of United States coal in excess of the 600,000 tons and in certain other circumstances to secure some coal if the U.S.A. availability was below 3,000,000 tons. The allocations of American coal to European destinations for the fourth quarter would not take place before August, and Mr. Shinwell said that it was not possible to forecast what the position would be at that date.

The Minister added that no contracts had yet been entered into regarding the supply of coal to the United Kingdom under the allocation. No firm estimate was therefore yet possible of the cost of that coal or of the freight and other handling charges, although estimates varying between £5 and £8 a ton had been mentioned.

The National Economy

The annual meeting of the Association of British Chambers of Commerce took place in London last week, and in his Presidential Address Sir Arnold Gridley, as well as surveying the Association's work during the past year, made several observations on matters affecting industry and the national economy at the present time. He said that we had been diverted from our primary industrial and commercial duties to deal with the changes and dislocations in so many of our basic industries in which the Government's nationalisation proposals had engulfed us. All such distractions and disturbances of confidence—a prerequisite of successful planning and achievement—were gravely retarding our industrial and commercial recovery.

While the Association had no party views, Sir Arnold said that it must study and if necessary frankly criticise the proposals of Government if it honestly believed they were likely to be prejudicial to British industry. He, himself, held firmly to the belief that free enterprise, in spite of its defects, was the basic system upon which our industrial greatness had been established, and upon which the restoration of our industrial prosperity depended. We had to realise, however, whether we liked it or not, that there must be in future a larger measure of Government general direction of industry, commerce and finance than we had known previously in our long industrial history. The reason for it was plain, for we could not lightly contemplate a return to the days of mass unemployment. We were all pledged to make every effort to secure a great expansion of world trade and for our people, and all peoples, a high and stable level of employment. Industrialised countries had become so interdependent, Sir Arnold continued, that one country alone could not achieve those objectives. That was why so many countries were now engaged in seeking agreement as to how those objectives could best be reached. Discussions were inevitable at Government level, though Government spokesmen must seek the best advice obtainable from those experienced in carrying on international trade and commerce. But after giving the general direction which industrial production should take, based on facts which Government alone was able to assemble, the Government should leave it to free enterprise to follow the lead given and to discharge its responsibilities. In short, Sir Arnold suggested, what was needed was continuous teamwork between Government and industry, each contributing its quota of special knowledge and experience, and leaving the other to fulfil its obligations to the common cause.

Employment and Unemployment

Figures issued by the Ministry of Labour in the early part of this week show that the total working population at the end of April numbered 20,210,000, and it is estimated that during that month the number of women at work increased by 10,000. The number of people employed in industry in April was 18,249,000 (12,656,000 men and 5,593,000 women), which was 329,000 above the mid-1939 figure. An increase of 206,000 in the total number of people in industrial employment is a sign of recovery from the fuel and power crisis in February and March.

The total number of people engaged in the manufacture of goods for the home market in April was 5,550,000, while those engaged in manufacturing for export was 1,484,000. In the Ministry's classification known as Metals and Chemicals—which includes the engineering and merchant shipbuilding and allied industries—2,857,000 people were at work on manufactures for the home market and 955,000 for the export market in April. It should be added that "home market" now includes the people occupied in the manufacture of equipment and supplies for the Forces. In March they numbered 440,000, compared with 5,121,000 at mid-1943.

The latest unemployment figures relate to May 12th, on which day there were 331,543 insured persons registered as out of work. The total so registered on April 14th was 426,989. There were also on the unemployment registers on May 12th, 12,186 uninsured persons, including 3513 boys and girls who had not entered industry. It should be added that the total of 331,543 insured unemployed included 16,548 temporarily stopped, 42,123 married women, and 15,928 ex-Service personnel who had had no employment since they were demobilised.

French Engineering News

(From our French Correspondent)

PARIS, June 13, 1947.

A Temporary Committee for Thermal Installations has been set up. All new fuel-using installations or modifications of any importance must be examined by the Committee, so that the interests of the country may in all cases be considered. In this way it is hoped that power may be made available from the most economical sources. The Committee comprises representatives of the Direction of Mines, Electricity, Gas, Oil Fuels and Industrial Co-ordination, as well as representatives of sections concerned with the allocations of coal and fuel oil. Prospective consumers are given specifications of fuels considered suitable for their installations. In addition, all installations using in excess of 300 tons of coal a month or 200 tons of fuel oil, or 100,000 cubic metres of natural gas, or 150,000 cubic metres of coal gas, or 100kW (for electric ovens) will be examined. It is stressed that the aim of the Committee is not to place obstacles in the way of industry, but, while helping to find suitable solutions to power problems, it will also consider the present deficiencies in power and raw materials, so as not to accentuate shortages.

* * *

Production of pig iron is expected to be hampered in the coming months by shortage of scrap, unless Ruhr coke is forthcoming to enable French ore to be used. Stocks of ore now represent about six months' extraction. Monsieur Morard, president of the Chiers blast-furnaces, has stated that the whole of the Longwy production, amounting to 300,000 tons a year, is being transformed into strip and wire by continuous modern rolling mills. Since it has been officially recognised that even small plants, by specialising, are capable of justifying themselves, he asks that the company should retain its present structure. Its plant, he says, has always been in the forefront of progress and there is no reason for including the company in the plans for nationalisation.

* * *

Monsieur Rene Fould, President of the Ship Constructors and Merchant Navy Chambre Syndicale, has stated that production capacity of French yards, which at the time of the liberation, fell to 20 per cent of that in 1938, had reached 75 or 80 per cent by July, 1946, and was expected to be fully restored by the end of 1947. By 1949, annual production capacity was expected to be 300,000 tons, against 200,000 tons pre-war. The programme of reconstitution and modernisation of shipyards is being financed by the shipbuilders themselves, but they have asked the State to order 1,500,000 tons over the next five years. The Government has not accepted these terms and is limiting its orders to 500,000 tons. The increasing production capacity of the yards will soon lead to shortage of labour. Increasing capacity from 200,000 to 300,000 tons will require about 60,000 men, or about double those employed in 1938.

* * *

Publication of the first results of the nationalisation of the gas and electricity industries in France cannot be called encouraging. Altogether the deficit amounts to about 41 million pounds, and to meet it the Minister of Industrial Production has decided to cut overheads by about 20 per cent. There is some doubt about whether private enterprise could have done better than the State, although it is contended that the plants could have been run more economically and that cuts now envisaged should have been introduced long ago. The Socialist argument is that industries transferred to the State were not flourishing concerns. No repairs had been undertaken since 1938. But in spite of post-war difficulties, gas production has increased from 143,905 cubic metres per month to 203,396 cubic metres per month, and this is held to justify nationalisation. To this, private enterprise answers that the State took over in order to increase efficiency and reduce costs, and that neither of these aims has been achieved.

Notes and Memoranda

Rail and Road

ST. PANCRAS STATION.—The London, Midland and Scottish Railway Company states that St. Pancras Station is to be closed either wholly or partially to rail traffic at six week-ends during June, July and August for the purpose of replacing the whole of the permanent way for a distance of 240 yards out of the terminus. The work includes the renewal of over forty sets of points and fifty crossings, extensive signal modernisation and reinforcement of the arches carrying the line over the L.M.S. stables at St. Pancras. While the work is in progress at week-ends, main line and local passenger trains will be turned back at Kentish Town, and Barking line services at Upper Holloway.

LONDON STREET WORKS PROGRAMME.—The Ministry of Transport says that nearly 1½ million square yards of roadway in the London traffic area are to be resurfaced within the next six months. Among the works proposed on important roads in the central area are the resurfacing of parts of Queen Victoria Street in the City, of Piccadilly, and Hamilton Place in Westminster, and of part of High Holborn. Reconstruction work will also be carried out in Portman Square, Gloucester Place and Edgware Road in St. Marylebone. The whole of the roadway of Vauxhall Bridge is to be resurfaced. It is proposed to reconstruct Surrey Lock Bridge (Rotherhithe Street, Bermondsey) and to remove the bridge over Limehouse Upper Entrance. The space formerly spanned by the bridge will be filled in with suitable material and the bridge replaced by a road (West Ferry Road, Poplar). Dual carriageways are to be built in the outer area on the Kingston By-Pass between Robin Hood and a point 200ft from Merton Spur Road, and on the Tooting–Reigate–Hookwood Road between Banstead cross-roads and Burgh Heath. An Order made by the Minister of Transport under the London Traffic Act, 1924, lays down the dates on which the work will start in important traffic thoroughfares, involving the closing of more than one-third of the carriageways. This has been done to ensure that there shall be as little inconvenience and obstruction as possible to traffic.

Air and Water

JAPANESE SHIPPING AS REPARATIONS.—The Merchant Shipping Reparations Committee in Shanghai has suggested that the Chinese Government should demand 1,000,000 tons of Japanese shipping as reparations. It is reported that of this tonnage, 500,000 tons would be allocated from Japan's current possession and the other 500,000 tons handed over in the form of new vessels within the next five years.

H.M.S. "AGINCOURT."—The flotilla leader "Agincourt," which has been constructed at the Hebburn yard of R. and W. Hawthorn, Leslie and Co., Ltd., has now been commissioned and has proceeded to her official sea trials. H.M.S. "Agincourt" is one of the flotilla leaders provided for in the 1943 Naval programme, and has a displacement of about 2200 tons, with a two-shaft arrangement of geared turbines, developing 50,000 s.h.p.

THE LATE SIR PHILIP DEVITT.—We have noted with deep regret the death on June 5th of Sir Philip Henry Devitt, part founder and chairman of the Nautical College, Pangbourne. In 1905 he joined the firm of Devitt and Moore, which managed ships trading to Australia, later on becoming senior partner and chairman of Devitt and Moore's Ocean Training Ships, Ltd. Sir Philip was a member of the Baltic Exchange, an underwriting member of Lloyd's, a trustee of the Honourable Company of Master Mariners, and honorary treasurer of the Institution of Naval Architects. He was seventy years of age.

BELFAST HARBOUR CENTENARY.—The centenary of the creation of the Belfast Harbour Trust is being celebrated this week. It is of interest to note that the port of Belfast now has 7 miles of quays and wharves, and the dockside sheds occupy an area of about 21 acres. The design of the port, it may be recalled, is such that waterborne traffic can be brought almost to the centre of the city, and the annual revenue is estimated to be round about £300,000. Recent developments have been the construction of the Pollock Dock system, the widening of the Alexandria graving dock, the remodelling of the Dufferin and Spencer docks, and the erection of a 150-ton crane on the Thompson wharf. During the war Belfast was naturally a naval base of the highest strategic importance, especially in waging the Battle of the Atlantic.

Miscellanea

B.B.C. CHAIRMAN.—The Lord President of the Council announced in Parliament last week that the King had been pleased to approve the appointment of Lord Simon of Wythenshawe as chairman and governor of the British Broadcasting Corporation.

THE MILITARY COLLEGE OF SCIENCE.—An advisory council for the Military College of Science has been constituted, under the chairmanship of Sir Henry Tizard, to advise the War Office on matters relating to scientific and technical education. It is understood that the council will maintain contact with the universities and technical institutes with a view to supplementing the resources of the College by outside courses.

SWEDEN'S IRON ORE EXPORTS.—Iron ore exports from Sweden in the first quarter of this year totalled 1,302,000 tons, compared with 861,000 tons in the first quarter of 1946. According to *The Anglo-Swedish Review*, exports of manufactured iron and steel declined by 11,100 tons to 23,000 tons in the first quarter of this year. Imports of pig iron in the same period totalled 21,000 tons, compared with 26,400 tons in the first quarter of 1946.

THE AMERICAN STEEL INDUSTRY.—Figures published recently by the American Iron and Steel Institute estimate that wages and salaries paid by the U.S. steel industry for the first three months of this year amounted to approximately 445,820,000 dollars, compared with 308,646,000 dollars in the corresponding period of 1946. The total number of employees in the industry in March was 608,800. Steel production in the U.S.A. in the first four months of this year amounted to 27,991,561 net tons, compared with 17,631,866 net tons in the corresponding four months of 1946. The average operating rate in April was 93·9 per cent of capacity, compared with 77·5 per cent in April, 1946.

VOICE FREQUENCY DIALLING AND SIGNALLING.—A useful booklet that was recently published by Standard Telephones and Cables, Ltd., Connaught House, Aldwych, London, W.C.2, describes the principles of voice frequency signalling and dialling, and shows how this system can be used to extend the use of automatic switch trains over various kinds of transmission circuits, including repeater or carrier circuits. The necessary equipment is available in three typical forms, which should be capable of meeting the majority of demands. Two direct applications are described in the booklet, first, the Standard automatic telephone system for operator and subscriber dialling; secondly, a simplified voice frequency dialling system suitable particularly for networks involving private automatic exchanges.

THE INDUSTRIAL USE OF THE GAS TURBINE.—The Ministry of Supply announces that a four weeks' course on the application of the gas turbine for industry is to begin on June 30th at the National Gas Turbine Establishment, Ladywood Works, Lutterworth, Leicestershire. Seventeen courses on the aircraft application of the gas turbine, at which about 250 engineers and Services technical officers represented Britain and the Dominions, have already been held at the Establishment. There are still a few vacancies for the forthcoming course, the cost of which, including tuition and dormitory accommodation, is £60. Applications should be sent to the chief instructor, Mr. W. R. Thompson, at the National Gas Turbine Establishment, Ladywood Works, Lutterworth, Leicestershire. It is hoped that a similar course will be held later in the year.

AUXILIARY GENERATING PLANT.—The British Internal Combustion Engine Manufacturers' Association, with the approval of the Ministry of Supply, is anxious to correct certain misconceptions about buying oil-driven auxiliary generating plant for factories. Neither the Ministry of Supply nor the Association is to sell the plant being made in British factories at the present time. Factory owners may buy this plant in the ordinary way from one of the engine makers to whom the Ministry has granted special allocations of materials. Endorsement by the Regional Controller of the Ministry which deals with the industry carried on in the factory is only necessary where preference in delivery is desired. Factory owners should therefore communicate their requirements direct to one of such engine makers or to the secretary, British Internal Combustion Engine Manufacturers' Association, 6, Grafton Street, London, W.1, who will give them the names of engine makers co-operating with the Ministry.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Institute of British Foundrymen

To-day, June 20th.—Annual Conference in Nottingham.

Institute of Physics

Friday and Saturday, July 18th and 19th.—INDUSTRIAL RADIOLOGY GROUP: Electric Lamp Manufacturers' Association, 2, Savoy Hill, W.C.2. A Symposium on "Methods of Crack Detection."

Institute of Welding

Wednesday, June 25th.—Grosvenor House, Park Lane, W.1. Annual dinner. 7.15 p.m.

Institution of Civil Engineers

Wednesday, June 25th.—N. WESTERN ASSOCIATION: Visit to open-cast coal sites in the Wigan area. 2.30 p.m.

Thursday and Friday, July 3rd and 4th.—NEWCASTLE-ON-TYNE ASSOCIATION: Summer meeting in Newcastle-on-Tyne.

Friday, July 4th.—BIRMINGHAM ASSOCIATION: Visit to Avonmouth Docks. 8.45 a.m.

Institution of Electrical Engineers

Saturday, June 21st.—S. MIDLAND CENTRE.—Visit to Meaford power station. 12.30 p.m.

Saturday, July 26th.—N. MIDLAND STUDENTS: Summer Outing. 9 a.m.

Institution of Heating and Ventilating Engineers

Monday to Wednesday, June 23rd to 25th.—Summer meeting at Eastbourne.

Institution of Mechanical Engineers

Wednesday, June 25th.—N. WESTERN GRADUATES: Visit to the *Daily Mail* Newspaper Offices at Deansgate, Manchester. 8.45 p.m.

Institution of Mining Engineers

To-day, June 20th.—Summer meeting in Edinburgh.

Iron and Steel Institute

Thursday, June 26th.—4, Grosvenor Gardens, S.W.1. "The Effect of Different Methods of Pretreating Iron and Steel before Painting." F. Fancutt; and "The Protection of Iron and Steel by Metallic Coatings," J. C. Hudson and T. A. Banfield. 2.30 p.m.

Public Works Congress and Exhibition

Monday, July 21st, to Saturday, July 26th.—London, Olympia.

Royal Meteorological Society

Saturday, July 5th.—Summer meeting at Portsmouth.

Stephenson Locomotive Society

Saturday, June 28th.—Visits to Brighton works, Redhill and Brighton running sheds, Southern Railway.

Friday, July 4th.—Visit to Swindon Works, G.W.R.

Technical Reports

The Reduction of Smoke from Merchant Ships. Fuel Research Technical Paper, No. 54. D.S.I.R. 1s. 3d. net.

Trials carried out on a marine-boiler ashore indicated that the production of black smoke involves losses of the heat available in the coal that could amount to as much as 10 per cent, but how much of this could be saved at sea was not known. In order to carry out the necessary experiments, a team from the Fuel Research Station made a voyage from London to Freetown, West Africa, and back in a cargo vessel of 7000 gross tonnage, having boilers equipped with smoke-eliminators. This report gives details and results of the trials carried out on board.

The ship had three Scotch, marine-type, forced-draught boilers. The two wing boilers were fitted out with all the necessary equipment for comprehensive boiler trials. Arrangements were made to work one boiler with smoke-eliminators and the other without them on the outward voyage, and the procedure was reversed on the homeward run. In this way, boiler characteristics and the weather factor could be dismissed and the true effect of smoke-eliminators determined. There was no special supervision of the ship's Arab firemen. They performed their normal duties and they decided when it was necessary to fire and how much coal should be fired. The results of the investigation can, therefore, safely be taken to apply to the normal operation of a typical merchant ship.

A complete heat account for the boilers was drawn up, which proved that the accuracy of these trials was equal to that of trials carried out under less trying conditions on land. These trials demonstrated that the elimination of black smoke enabled an economy of at least 5½ per cent to be effected, equivalent to saving 1 to 1½ tons of coal per day on this class of merchant ship.

Personal and Business

THE BUILDING CENTRE, 9, Conduit Street, W.1, announces that its telephone number is now Mayfair 8641.

MR. L. S. RICHARDS has been appointed electrical engineer to Henley's Tyre and Rubber Company, Ltd., Gravesend.

MR. I. W. F. FAIRHOLME has been appointed general works manager of Richard Johnson and Nephew, Ltd., Manchester.

HOPKINSON MOTORS AND ELECTRIC COMPANY, Ltd., has moved to new works at Birchgrove, Cardiff (telephone, Whitchurch 1691).

MR. D. L. THOMPSON has been appointed planning and production engineer to the North-East Engineering Bureau, Newcastle-upon-Tyne.

SIR LEONARD PEARCE, C.B.E., engineer-in-chief of the London Power Company, Ltd., has been elected an hon. member of the Institution of Mechanical Engineers.

SELECTRA, Ltd., 42, Selcroft Road, Purley, Surrey, has recently been formed as a company of electrical and mechanical engineers. The directors are Mr. E. W. and M. C. Krebs.

THE VISCO ENGINEERING COMPANY, Ltd., announces the following appointments to the board of directors:—Mr. F. C. Smith, works manager; Mr. L. C. Ellis, chief engineer; and Mr. E. H. Hilton, secretary.

MR. H. A. V. BULLEID, A.M.I. Mech. E., has relinquished his position as assistant research manager, Vickers-Armstrongs, Ltd., Elswick, to join British Nylon Spinners, Ltd., Pontypool, as deputy chief engineer.

EDGAR ALLEN AND CO., Ltd., announces the appointment of Mr. J. P. Lewis to an executive post at Imperial Steel Works, Sheffield. Mr. C. N. Gee has been appointed special technical representative of the company in Southern England.

POWELL DUFFRYN, Ltd., announces the formation of a subsidiary to be known as Powell Duffryn Carbon Products, Ltd., which will manufacture at Hayes, Middlesex, the carbon products hitherto developed experimentally by Delanium, Ltd., at Battersea. The activities of the Delanium laboratories are to be continued and the name of Delanium, Ltd., has been changed to Powell Duffryn Research Laboratories, Ltd.

THE BRITISH ALUMINIUM COMPANY, Ltd., announces that Mr. Freeman Horn is retiring from his position as intelligence officer and manager of the special products department. He is being retained in a consultative capacity until the end of 1947. Mr. L. V. Chilton, M.A. (Cantab), has been appointed manager of the intelligence department and Miss W. Lewis, B.Sc., information officer. Responsibility for the sale of special products is being transferred to the sales division under Mr. R. M. Warrington, and Mr. S. F. Derbyshire, manager of the alumina department of production division, will be responsible for technical matters affecting special products.

Reports on German and Japanese Industry

Limited numbers of copies of the reports of Intelligence Objectives Sub-Committees on German and Japanese Industry listed below can be obtained from H.M. Stationery Office at the prices stated.

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A Seven-Day Journal

The Motor Whale Factory Ship "Thorshavet"

An event of unusual interest took place at Harland and Wolff's Belfast yard on Thursday, June 19th, when the new motor-driven whale factory ship "Thorshavet" for the Norwegian Whaling Company A/S Thor Dahl was launched. The naming ceremony was performed by Mrs. Winge Sorensen, the wife of a director of the owners. The new ship has a length between perpendiculars of 560ft, a breadth moulded of 77ft, a depth moulded to factory deck 39ft 6in, to flensing deck 56ft, a mean draught summer freeboard of 34ft 6in, and a deadweight carrying capacity of about 21,000 tons. She will be constructed to Lloyd's Register Special Survey and for classification to Norske Veritas. The flensing deck will have a length of 291ft and a width of 77ft. The factory has a length of 336ft and a width of 77ft, and its main machinery will include twenty Kvaerner boilers, with glue water machinery and separating plant. Separate electric motor drives are adopted and sixty-five motors with a total connected load of 700kW will be installed. The oil will be carried in ten main cargo oil tanks, having an approximate capacity of 21,000 tons. Twin-screw Harland-B. & W. type engines are to be installed, of the six-cylinder single-acting four-cycle type, having 740mm bore cylinders and a stroke of 1500mm, developing their designed power at a conservative rating and running at 110 r.p.m. Six single-ended cylindrical multitubular boilers will provide steam for the factory. The oil engine driven auxiliary machinery supplied by the builders includes four 425-kW generating sets, two 100-kW sets and two 35/40-kW sets, one of which will be steam driven. Excellent accommodation will be provided for the owners, officers, crew and the factory staff and workers, numbering in all some 392 persons. Speaking after the launch at the luncheon, Sir Frderick Rebbeck, the chairman of Harland and Wolff, Ltd., expressed his surprise that the axe had fallen so heavily on the shipbuilding industry, which had not been accorded a place in the first six steel priorities. More coal was needed, he said, if the necessary steel was to be produced. The reserves of steel at the company's Belfast and Govan yards were, he added, practically finished, and the yards were receiving less than 50 per cent of their normal requirements.

The Task of the Foundryman

In the course of an address given last week in Ayr, to the annual conference of the Amalgamated Union of Foundry Workers, Mr. Arthur Woodburn, the Parliamentary Joint Secretary to the Ministry of Supply, dealt with the contribution the foundryman could make to production. Everyone, he said, now realised that progress was only possible if we repaired the six-years' war destruction, and created a basis for higher standards. This could not be done by merely increasing the speed of mass production, which, he pointed out, was completely helpless in the face of an absence of raw materials or the products of basic industry. Those products, he said, depended not on mass production but on personal skill and effort. Coal and timber production depended on their availability and the number of men employed to obtain them. It was hoped that the increased efforts of the miners would rescue us from our present difficulties, but he thought that the permanent solution of the problem would come from the rest of the community providing these workers with tools to facilitate their work. They, in turn, depended upon the great engineering industry, which had as its basis the skill and work of the foundryman. It was sometimes forgotten that the work of a moulder was an art which called for a delicacy of touch which would dignify any craftsman in the world. The term "worker" should, he said, cover all those who contributed service to the community. Just as the community must respect the craftsman's part in producing wealth, so the worker must respect the part played by the organisers, the technicians and the scientists. The Government had stressed the contribution which could be made by science and planning and had stimulated and subsidised research and development in all sections of industry. The Cast Iron Research Association was now celebrating its 25th anniversary. Cast irons of to-day had a tensile strength double that of 25 years ago, and high duty irons with new properties were now being produced. Mr. Woodburn closed his address by saying that he had faith in our people and felt that they would surmount their present difficulties and be an example to the world in good humour, fellowship and high moral purpose.

International Conference on Soil Mechanics

It is announced by the Institution of Civil Engineers that the Second International Conference on Soil Mechanics and Foundation Engineering will take place in Rotterdam, from June 21st to June 30th, 1948, on the invitation of the Netherlands Government and the Municipality of Rotterdam. Among the technical and scientific topics selected for discussion are the following:—Theories and hypotheses, laboratory and field investigations, stability and deformation of earth and earth constructions, stability and movements of soil retaining constructions, stress distributions under foundations, and the settlements of structures, pile foundations and pile-loading tests, problems in highway and runway constructions (superstructure), methods for improving the mechanical quality of soils, and ground water movements. Topics of a general character to be discussed will include a survey of the existing institutions and individuals working in the sphere of soil mechanics, and suggestions for international co-operation. Anyone interested in the Conference, whether from the standpoint of practical application or research or teaching, is welcome to attend the meetings and to contribute reports or discussions. The President of the Conference is Professor K. Terzaghi, and Professor A. Casagrande is the Secretary. An organising committee has been appointed under the chairmanship of Ir. J. P. van Bruggen, with Ir. T. K. Huizinga as secretary, and Ir. W. C. van Mierlo treasurer. The Institution of Civil Engineers has convened a British National Committee on Soil Mechanics, under the chairmanship of Mr. W. K. Wallace, and full particulars of the forthcoming conference can be obtained from the Secretary, the Institution of Civil Engineers, Great George Street, London, S.W.1.

Motor Taxation Changes

Important changes in the taxation of motor-cars were announced last week by Mr. Hugh Dalton, the Chancellor of the Exchequer, during the Committee stage of the Finance Bill in the House of Commons. He announced that the annual licence duty on all private motor-cars first registered on or after January 1, 1948, will be at a flat rate of £10. The cubic capacity tax, which had been paid on those cars which have been registered this year, will be adjusted, and they will come under the flat rate next year. In order to counterbalance any loss of revenue which may be occasioned by the change in taxation, Mr. Dalton further announced that the purchase tax on cars whose retail price, exclusive of purchase tax, is £1000 or more, roughly equivalent to cars whose price inclusive of purchase tax is £1250 or more, will be doubled. Thus the 33⅓ per cent existing tax will be increased to 66⅔ per cent, a measure, Mr. Dalton hoped, which will favour the exporting of high-priced cars. There will be no increase in the petrol tax. On Monday, June 23rd, the relevant resolutions covering these changes in taxation were put before the House of Commons.

The South Wales Tinplate Industry

In our issue of March 7th we outlined the plans for the development of the steel sheet and tinplate industry in South Wales, which a new company, the Steel Company of Wales, proposes to carry out. Last week, in Parliament, the Minister of Supply was asked if he had any statement to make regarding the location of the cold reduction plant for tinplate. In a written reply, the Minister explained that after weighing all the social and technical factors involved, the Government had concluded that Trostre, near Llanelly, was the most suitable place at which to erect the cold reduction plant for tinplate, and that new heavy industries to employ the redundant manpower should be located in or near Swansea. This decision, the Minister's reply stated, had had to be made in the light of the fact that the reorganisation of the tinplate industry would cause, as the new plants came into operation, the redundancy of a considerable number of persons at present occupied in that industry. The Government therefore regarded it as an essential part of the scheme that proper opportunities of employment should be provided for those men who would become redundant owing to the starting up of the new tinplate plants. The reply added that the location of the cold reduction plant for sheet steel had not yet been decided.

The Velocity of Light

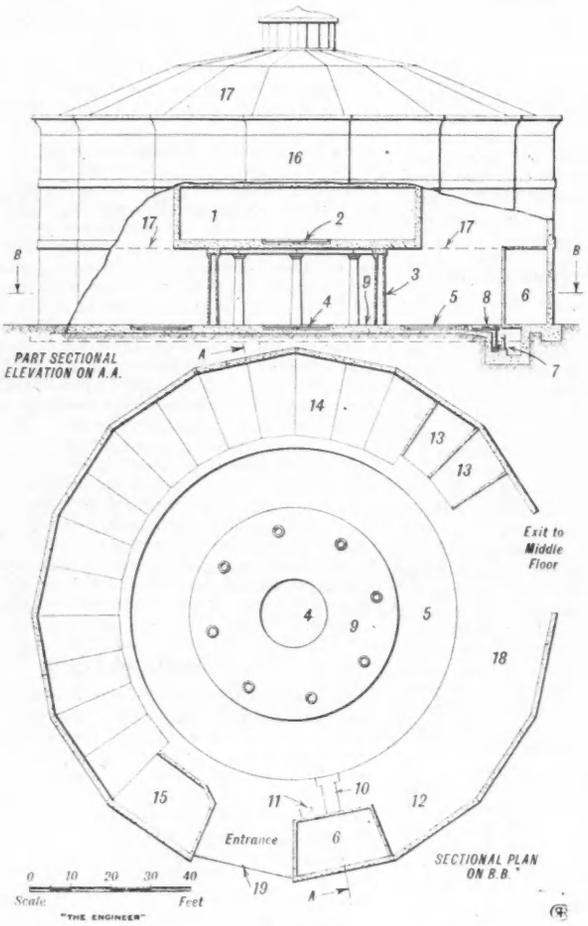
At the exhibition of work held at the National Physical Laboratory last week one item shown to the visitors seemed at first sight to promise something in the nature of a scientific sensation. The exhibit in question consisted of apparatus for the determination of the velocity of electro-magnetic waves. According to Maxwell's theory that velocity is the same as the velocity of light and according to the theory of relativity there can be no velocity greater than that of light. At the laboratory measurements so far made with a new form of apparatus indicate that the velocity of electro-magnetic waves is 17 km per second greater than the accepted value of the velocity of light. The experimental method employed is based on the determination of the frequency of electrical resonance of a hollow copper cylinder about 8cm long and 8cm in diameter. The frequency depends only on the dimensions of the cylinder and the velocity of propagation of the electro-magnetic waves. That velocity can therefore be determined by measuring the dimensions of the cylinder and its frequency of resonance. The dimensions of the cylinder were measured to the three hundred thousandth part of a centimetre and the frequency of resonance with an accuracy of a few parts in a million. That the velocity of electro-magnetic waves has been found to exceed the accepted value of the velocity of light will not, we fancy, cause Einstein grave concern. In 1927 Michelson, using the rotating mirror method, found the velocity of light *in vacuo* to be $2{\cdot}9980 \times 10^{10}$ cm per second. By the same method he refined this figure in 1935 to $2{\cdot}9977 \times 10^{10}$. The addition of 17 km per second to this second figure would give us almost precisely the mean value of these two determinations. The theory of relativity is therefore not in danger, as yet, of being disrupted.

A Swiss Mechanised Car Parking System

By CHRISTOPHER F. ARMSTRONG, A.M. Inst. C.E.

WHEN in Switzerland, visitors to Lucerne usually take the opportunity to see the Panorama painted by E. Castres and others at the beginning of the present century to depict the entry into Switzerland of the French Army defeated in the Franco-German War of 1871. These paintings cover the internal circular walls of the top storey of a three-storey building erected for the purpose in the Löwenstrasse in 1889.

The lower floors, however, never seem to have had a definite purpose assigned to them until 1925. At that time Edward and Frank Koch, who were using a smaller establishment nearby as a garage, decided to purchase the building and expand the business, making use of these lower floors as a car park. The decision to adopt the turntable principle of parking was evolved from the fact that the building was roughly circular in shape, and from perusal of a technical journal, which included proposals and sketches for such a system. The possibilities were accordingly discussed between Messrs. Koch and Messrs. Schindler, the Swiss lift manufacturers, and a scheme was drawn up. In this the middle floor was to be provided with a small central turntable on which cars could be turned by hand to face in any desired direction. The building on this floor was to be used primarily for storing cars to be laid up during winter months and in emergency as an overflow park when the ground floor space was filled to capacity. The two floors were to be connected by a semi-circular ramp within the building. The power-operated parking ring was to be installed on the ground floor.



1—Overflow Parking Space
2—Upper Manual Turntable
3—Supporting Columns
4—Lower Manual Turntable
5—Moving Ring Turntable
6—Cash Sales Office
7—Motor Room
8—Transmission Gear
9—Inner Static Area
10—Covers to Transmission Gear
11—Controller's Platform
12—Car Washing Bay
13—Lock-Ups
14—Fenced Parking Bays
15—Tyre Repair Bay
16—Panorama on Upper Floor
17—Skylight
18—Auxiliary Parking Space
19—Door (with Power Lift)

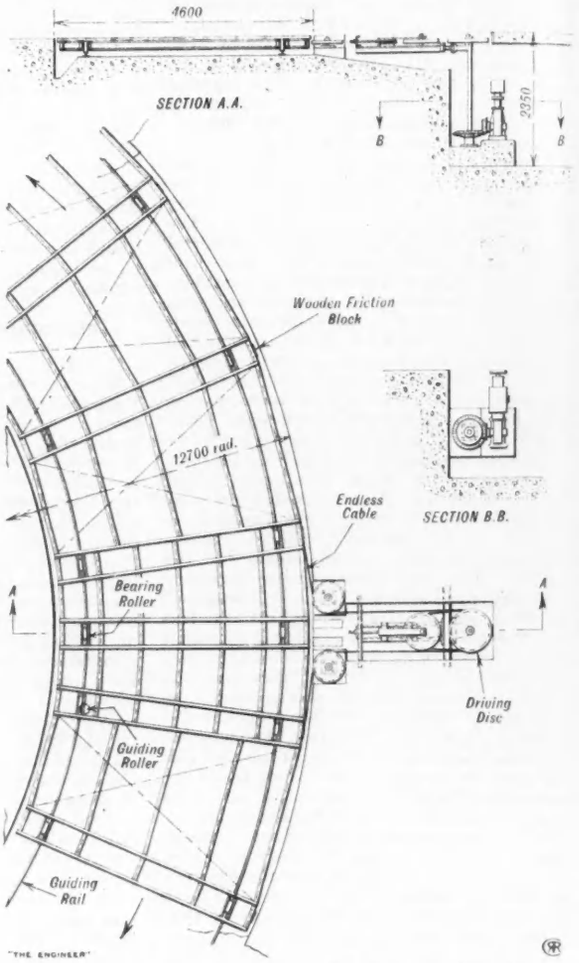
ARRANGEMENT OF PANORAMA GARAGE

The works to Messrs. Schindler's designs were carried out during the period 1925–27. Subsequent inquiries were made in America, but it was never established whether the proposals referred to in the journal were, in fact, put into practice there, and so far as is known the system adopted at Lucerne is unique.

During a recent visit to Switzerland the author was able to take advantage of facilities kindly offered by the proprietors to examine the system in detail and to observe the behaviour of traffic using the garage.

General Description

The garage provides a twenty-four-hour service throughout the year. On the ground floor there is a central turntable about 16ft in diameter, used for manœuvring small cars by hand; an inner static area reserved for this type of car in which are situated eight hollow cylindrical concrete columns supporting the upper floor; a power-operated annular turntable which will be referred to hereafter as the "moving ring"; and an outer static area which consists partly of an open parking area and partly of a number of lock-up parking bays. The operating equipment includes the controller's pedestal, cash sales office, main door operating gear and the operating motors for the moving ring, housed in a small basement. Drawings reproduced herewith illustrate the general arrangement of the building and the mechanism for operating the annular turntable.



ANNULAR TURNTABLE OPERATING MECHANISM

Moving Ring and Operating Gear

To accommodate the moving ring a circular groove, 1ft deep, 15ft wide and of 68ft mean diameter, was cut in the existing floor and provided with a pair of concentric rails on which the moving ring rotates. The ring itself consists of a light metal framework containing a number of wheels about 9in in diameter on ball bearings running on the rails, and a timbered deck.

The ring is rotated by means of an 8 h.p., three-phase electric motor, running at 1500 r.p.m., taking 16 amperes on 380 volts. It is mounted with the spindle horizontal and is similar to the motors used by Messrs. Schindler to operate their lifts. A small auxiliary electric motor taking 0·8 amperes on 380 volts at 600 r.p.m. is used to actuate the external contracting band brake operating on the main shaft.

The transmission consists of a bevel gear driving a vertical shaft leading up from the basement to ground floor level. To the top end of the shaft is keyed a 27in diameter double-sheave cable pulley. The drive consists of an endless steel cable of about 2in circumference, which passes right round the greatest diameter of the moving ring and over a pair of 20in diameter idler pulleys. The working tension on the cable is maintained by running it over a fourth pulley, 2ft in diameter, the mounting of which includes a powerful coil spring. The setting of the latter can be varied by means of a threaded bar and lock nut. The arrangement may be followed by reference to the drawings and photographs reproduced herewith.

Advantages claimed for cable operation, as against the use of gearing, are :—(1) Less power is required, (2) replacement of worn parts is simpler and cheaper, (3) the slight degree of flexibility due to cable stretch is very desirable, as the shock on the transmission is less than with a toothed ring and gear wheel.

The transmission is controlled from a pedestal overlooking the whole parking area and a simple rheostat control arm is used. This has four positions on each side of neutral, so that the ring can be swung in either direction, and when the arm is returned to the neutral position braking of the ring is fully automatic through the action of the small electric motor referred to earlier. In the event of the system being overloaded for any reason, a " breaker " in the power circuit is thrown out and no serious damage to the mechanism is possible. The maximum peripheral speed of the ring is 50ft per minute.

Reliability of the turntable mechanism has been remarkable. The original main electric motor has recently been replaced by a new machine, after just on twenty years' reliable service. The original cable was replaced in 1935, after eight years' service, by the one which is still in use, and which appears substantially unworn after its eleven years' service. The rest of the mechanism is that originally installed and also appears substantially unworn.

The system consumes about 650 kWh per month, represented by 100f., or £70 per annum. The equivalent cost at 1d. per kilowatthour would be about £33. The power used is therefore not great, the main load being expended in bringing the ring up to speed, after which the loading is very light. The firm felt themselves to have been amply justified in adopting the moving ring system. It had proved a definite commercial success in the past and they were quite satisfied with its operation and reliability. In some respects they had been handicapped by having had to adapt an existing building, and had it been possible to design a building to suit the mechanism they would have used a circular form of construction for the parking space only, and not for the building as a whole. They would also have given themselves rather more space in all directions in view of the modern tendency, particularly in America, to produce wider and longer cars.

CABLE TENSIONER AND PULLEYS

CAR TAKING UP POSITION ON ENTERING

Other Equipment

Apart from the revolving turntables, the following is some of the equipment provided in the building :—

(1) In order to conserve heat during the winter months, the main door was designed as a single timber structure, with glass panels, the whole being moved by an electric motor operated by the controller. On opening, the door rises vertically into a recess in the wall of the building, thus forming no obstruction when fully opened.

(2) The lower floor has a ventilating device, consisting of an electric suction fan and the eight hollow concrete pillars previously referred to. Air and exhaust fumes are sucked through orifices at the top of the pillars, and are expelled outside the building. It is thus a ventilating, but not an air-conditioning system.

(3) The space outside the moving ring includes seventeen lock-up bays, two of which are walled in with vertical " lift and roll " flexible doors. The open bays have metal gauze partitions and vertical lift doors of the same material. Clearance at the doors is approximately 9ft, and the length of bay is sufficient to take the largest cars. There is also space for thirteen cars not in partitioned bays, but this number is reduced to nine if a gangway has to be kept clear to the upper storey. Thus the total garage capacity on this floor is seventy-six, of which thirty-one cars can be accommodated on the moving ring, thirty outside it, and fifteen on the inner static area. As a general rule, the ground floor is filled to capacity during the night.

Parking Technique

The custom in Lucerne is for car owners to use the garage mainly as a night park. Businessmen arrive between 7.30 a.m. and 8.30 a.m. to collect their cars to go to work, returning between 6 p.m. and 7 p.m. During the morning the garage gradually empties as cars are taken out for shopping, &c., and by about 4 p.m. the garage is the least full. Thereafter, the influx increases up to a peak about 6.30 p.m., and for the remainder of the evening the capacity is gradually used up until by midnight nearly all the cars are in. The only exception to this is on Saturdays and Sundays, when cars are driven in during the morning from the surrounding country and leave during the evening—Lucerne being a pleasure resort.

To examine the operation of the parking system, it will help to follow an owner who arrives at the garage early in the morning to collect his car.

Before his arrival, the controller on his elevated platform and two assistants will have moved one or two cars off the ring and out of the garage to clear a working space. The owner walks to his car, which may be in one of three positions, *i.e.*, in one of the outer parking bays, on the inner static area reserved for small cars or on the moving ring itself. If he is a regular customer, he will save the most time by starting the engine and switching on his side lights to indicate his position to the controller. Meanwhile, if the car is in one of the outer bays, the controller will be swinging the ring to present the driver with a clear space on which to run. When the car is on the ring, the latter is rotated until the car can be driven either straight out or straight across the ring and out. If the car is already on the ring, it is only necessary to turn it so that the car is in line with the exit. If the car is on the inner parking area, it is

only necessary to drive straight out across a space in the ring.

In the evening, when the driver returns, he drives straight in to find that the ring has been left in such a position that by driving radially on to it and parking with his front wing just clear of the next car, he is automatically using the ring space to the best advantage, as shown in one of the photographs reproduced herewith. As soon as the driver has left, the ring is moved round one car space in a clockwise direction. This facilitates close parking with left-hand drive cars.

In certain positions, for driving the small cars out more easily, it may be convenient to use the central turntable. When two cars are ready to move out at the same time and the first is already on the moving ring, there is a saving of time if the ring is stopped for the second car to be driven on before the first is in a position to drive out. If this is done it often happens that both cars can be driven from the garage together. Wherever a car may be found to have been left overnight, it never has to be rotated through more than 90 deg of the ring before it can be driven out. Any pause in the influx of cars is used to transfer cars from the moving ring to the outer parking areas or bays, the cars chosen for removal being those which will ensure that the spaces they leave are about 90 deg apart. When a small car arrives, it is driven straight to the inner static area, and when this fills up beyond a certain point parking is helped by the use of the central turntable. With experience, the controller knows at once what the movements should be to clear cars wishing to leave or to park incoming cars in the shortest possible time. On the other hand, co-operation from drivers is necessary if the system is to work smoothly, and at least one other attendant is needed to ensure that cars are parked with a minimum waste of space.

Time Trials

Brief time trials were carried out, and even in rush periods the system worked quite smoothly, and the figures obtained appear very satisfactory, bearing in mind that only a single entrance/exit is available. It was stated that on economical grounds the traffic flow rate at Lucerne did not justify the provision of more than one cash sales attendant and set of office equipment. The drive-out timings were taken from the time the driver entered the garage to the time the front wheels of the car passed off the ring. The average of eight tests was 1 min 35 sec., the longest time recorded being 3min 35 sec. and the shortest 33 sec. The drive-in timings were taken from the time the car entered the garage to that when the driver had alighted and closed the car door. The average of seven timings was 47 sec., the longest time being 2 min 17 sec and the shortest 22 sec. In this case the longest time was hardly a fair example, the average of the remaining six times being 32 sec.

All these are timings on or off the moving ring itself. In addition, two small cars driven off the central area averaged 1 min 15 sec, and the car which had first to be pushed on to the moving ring from an outside bay took 3 min 22 sec ; also three small cars driven in on to the central static area averaged 33 sec. The times taken to obtain parking tickets were not recorded, as these are a function of efficient lay-out and staffing, and not of the type of parking mechanism adopted.

An Engineer Looks at Bolivia

By ROLT HAMMOND, A.C.G.I., ASSOC. M. Inst. C.E.

No. III—(*Continued from page 536, June 20th*)

BOLIVIAN prosperity is also greatly dependent upon improved communications. Having no seaboard, access to the country is through the ports of Mollendo, Antofagasta, or Arica, or by railway from Buenos Aires. The Central Argentine Railway from that city connects to La Paz through Tucuman ; the construction now proceeding on the Southern Railway of Peru on a new main line to connect La Joya, on the existing main line, with the improved port of Matarani, on the Pacific coast, a distance of 40 miles.* This line will enable the present main line from La Joya to Mollendo to be abandoned, and the second port of Mollendo will probably be served by the branch line from Matarani, from which it is distant nine miles down the coast (Fig. 3).

In 1941, improved harbour facilities were completed at Matarani. They included two breakwaters, one 2122ft long, and the other 492ft long, with a 460ft channel between their heads. Within their shelter is a 1476ft quay, at which vessels drawing up to 36ft of water can berth ; this quay is served by four warehouses, each 280ft long and 88ft wide, built of cement asbestos sheeting, supported by structural steel frames, and generally of fireproof construction. All port facilities are provided ; the first twelve miles of the new line from La Joya to Quebrado Guerrero were first completed and the whole forty-mile line is now open to traffic.

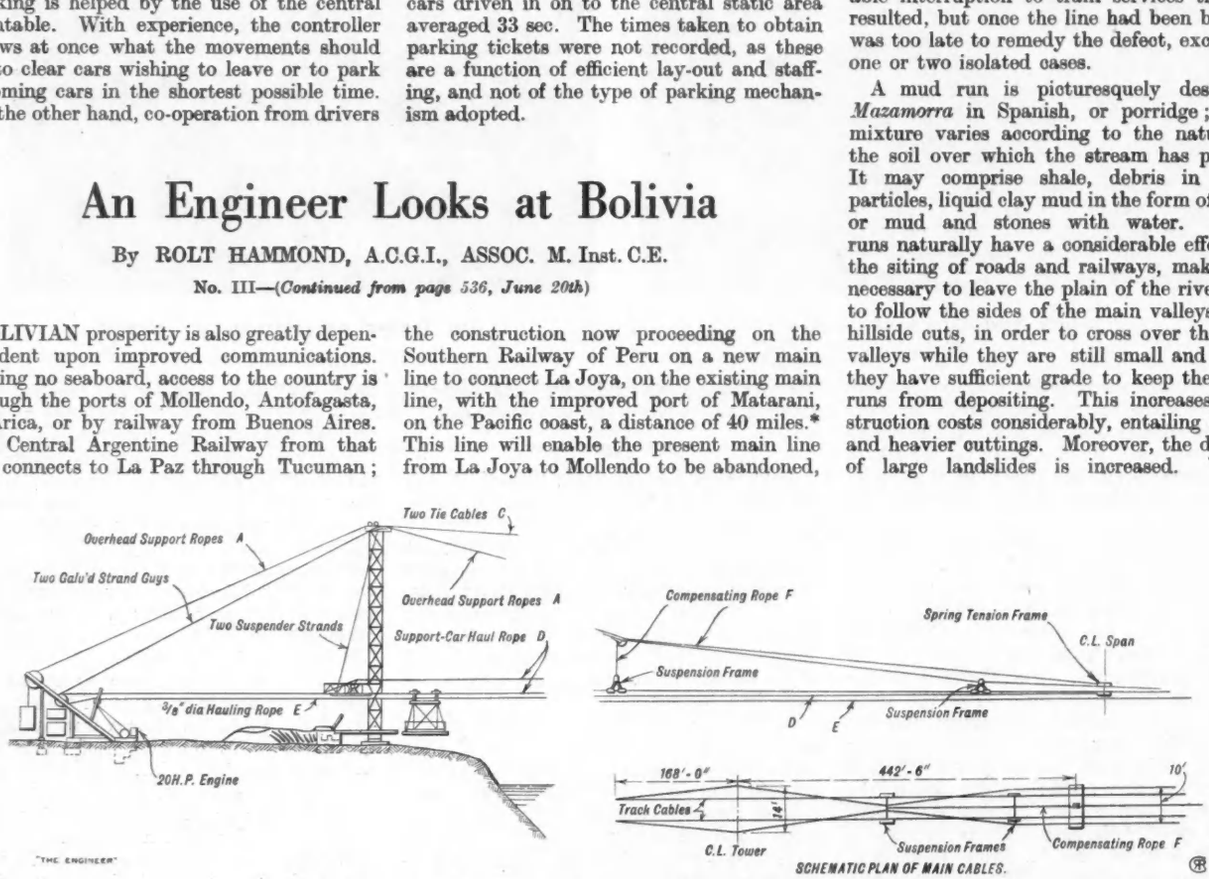
* See *The Railway Gazette* for May 4th, 1945.

Mud Runs

One of the more interesting engineering projects carried out in Bolivia in recent years has been in connection with mud runs, which have adversely affected train services on the Bolivian Railway ; these works have been described in detail by Morum†, who was responsible for carrying them out.

His paper deals mainly with work on the branch line connecting Oruro and Cochabamba, the worst line for mud runs in Bolivia; it was originally located by engineers with no previous experience of Bolivian mud runs. Following the usual methods, they located the line in convenient river valleys. Although they allowed ample outlets for any water which might be brought down by the side valleys, ravines less than 4 km in length, they did not allow for much detritus being brought down at the same time. Considerable interruption to train services thereby resulted, but once the line had been built it was too late to remedy the defect, except in one or two isolated cases.

A mud run is picturesquely described *Mazamorra* in Spanish, or porridge ; the mixture varies according to the nature of the soil over which the stream has passed. It may comprise shale, debris in small particles, liquid clay mud in the form of ooze, or mud and stones with water. These runs naturally have a considerable effect on the siting of roads and railways, making it necessary to leave the plain of the river and to follow the sides of the main valleys with hillside cuts, in order to cross over the side valleys while they are still small and while they have sufficient grade to keep the mud runs from depositing. This increases construction costs considerably, entailing larger and heavier cuttings. Moreover, the danger of large landslides is increased. When the Central Northern runs to the frontier at La Quiaca, and from Villazon a Bolivian train is taken to Tupiza and Atocha, where a connection is made with the Bolivian Railway Company for Uyuni, Oruro Viacha and La Paz, with a total mileage of 1663. Considerable improvements in access to Bolivia from the coast should result from



FIGS. 1 AND 2—CABLEWAY OVER THE RIVER ESPIRITU SANTO

† "The Treatment of Mud Runs in Bolivia," by S. W. F. Morum, B.Sc. (Eng.). Assoc.M.Inst.C.E. *Journal* Inst.C.E., Vol. I, 1935–36.

engaged on the construction of the Potosi-Sucre line, Morum had to deal with as much as 200,000 cubic metres of slide in a section 10 km long during a rainy season.

When liquid and running, the mud run

has an angle of repose of only 5 deg. to 10 deg. With a water content of 50 per cent or more, when dried in the sun it settles and shrinks into a compact mass harder than the original soil, with an angle of repose of from 60 deg.

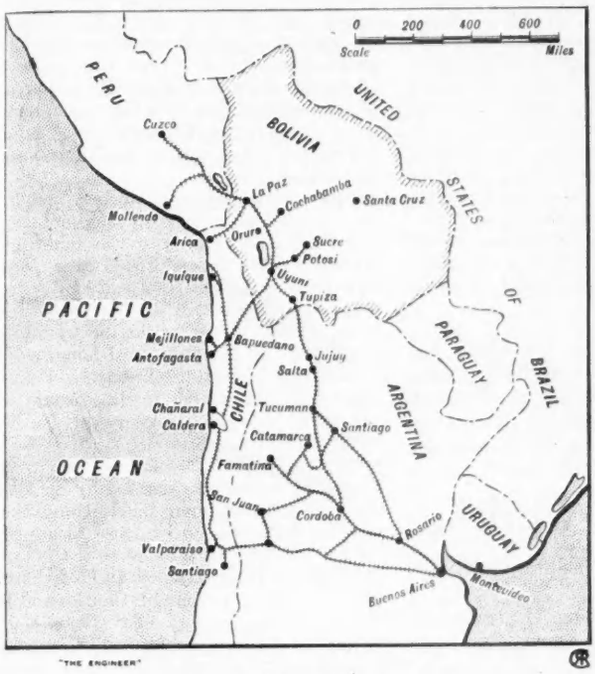


FIG. 3—BOLIVIAN RAILWAY SYSTEM

to 80 deg. This applies to all mud runs, except those consisting largely of shale.

AERIAL TRANSPORTER BRIDGE

An interesting aerial transporter bridge, incorporating a novel arrangement of cables, making the path of the car virtually horizontal, was recently constructed in Bolivia and has been described by William A. Reeve; Figs. 1 and 2 are taken from his article‡.

This transporter can carry a 6-ton loaded truck across the span of 885ft in 1½ minutes; motive power is provided by a petrol engine of only 20 h.p., as compared with 60 h.p. which would be necessary for the operation of a conventional cableway. The bridge is on a road built by the Bolivian Government to improve communications in the provinces of Chapare and Beni; here a large area has been practically isolated by the Andes, and by intractable rivers. Indeed, Reeve states that on this 117 mile road from Cochabamba, through virgin jungle, some of the most difficult terrain in the world is encountered near the Espiritu Santo, a tributary of the Amazon, which virtually blocked further advance.

This river has an undulating bed with ridges of rock extending above the surface of the water at several points; this prevented the operation of a ferry and it was not unusual for large pack trains to be held up for days at a time awaiting a favourable opportunity to cross the river. Urgent demands for natural rubber made this river crossing vital, the provinces on the far side being rich in that commodity.

A bridge for such a span would have been too expensive and it was decided that an aerial transporter bridge would be the most economical solution of the problem. A contract was therefore awarded to John A. Roebling's Sons Company for a structure with a span of 885ft between shore towers, the latter being 100ft and 120ft high, respectively.

The sketch (Fig. 1) shows that the structure is, in effect, a single span aerial tramway. The main feature of the design is a system of overhead supporting cables, dividing the main span into five short spans, supported by A-frame track rope saddles; these intermediate-supports reduce the deep sag that would otherwise be produced by the load. Moreover, the overhead support ropes are brought together above the compensating A-frames in such a manner as to damp out lateral swaying (Fig. 2) and thus to prevent sway building up in high winds. In order to maintain stability of the towers, their tops are linked together across the span by two galvanised wire strand cables, with inclined back-stays anchored to the counterweighted anchor frames.

In addition to the levelling effect of the support at four intermediate equidistant points in the 885ft span, a compensating support system helps still more to prevent sag at the load concentration. This is effected by interconnecting the support ropes to the two A-frames nearest the towers by independent spring-loaded tension rope, operating over sheaves attached to the main support cable.

A tension frame is arranged to slide along the overhead support cables in its function as transmitter of compensation between the A-frames nearest the towers. Thus any concentration of gravity loading at or near one of these frames produces an uplift reaction on the rope system at the corresponding point near the far tower which takes part of the load and reduces the sag at the carriage.

The transporter carriage runs on eight wheels along two track cables, the cage platform being 20ft long and having a clear width of 9ft. The haulage rope is of the endless type, maintained at constant tension by a spring-loaded sheave at the opposite anchorage of the transporter; the rope is always in movement in the same direction, and all controls are in the moving transporter car.

In order to prevent deep sagging of the slack or back tension part of the hauling rope across the span, a pair of special carriages is provided approximately 442ft apart, having supporting sheaves to hold up the sag of the rope. These carriages are connected by a secondary hauling rope forming an endless circuit; one carriage is always at mid-span when the transporter car is in either tower terminal station. One carriage is pushed ahead by the transporter car, the other carriage trails 442ft behind.

This bridge was designed and fabricated at the Roebling plant in Trenton, New Jersey, and was then shipped to Arica, Chile; thence it was shipped by rail to La Paz, 12,000ft above sea level. From La Paz the materials travelled by way of Cochabamba to the site in the jungle of Matto Grosso, moving by such varied means as rail, truck, mule and canoe. Erection was carried out by unskilled labour under the direction of Mr. Reeve, and it is a great credit to his organising skill that in only eight weeks the transporter bridge was installed and running, although not a single worker had ever before seen mechanical things of this kind.

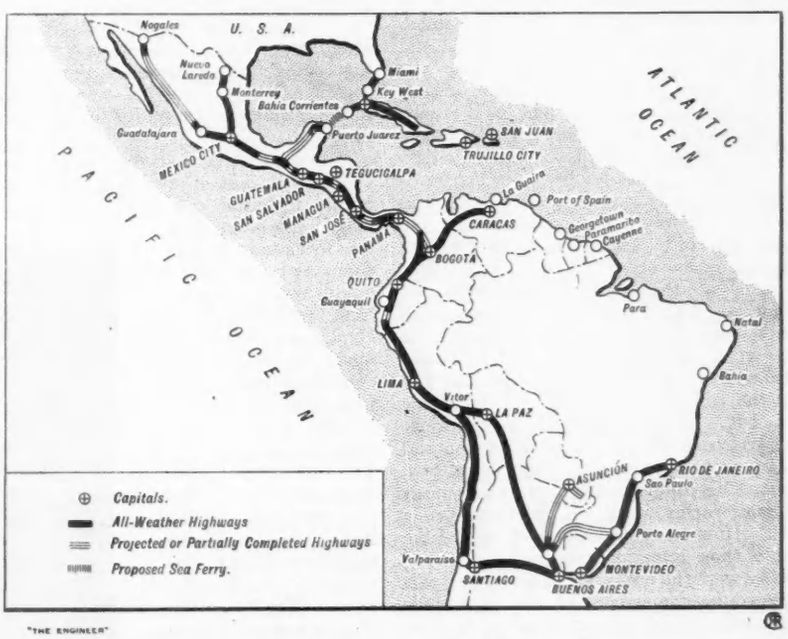


FIG. 4—PAN-AMERICAN HIGHWAY

PAN-AMERICAN HIGHWAY

The great Pan-American Highway, shown on the sketch map (Fig. 4) is likely to have a considerable influence on the future pros-

‡ "Aerial Transporter Bridge in Bolivia," by William A. Reeve, Senior Engineer, Bridge Division, John A. Roebling's Sons Company, Trenton, N.J., *Engineering News-Record* for June 14th, 1945.

perity of Bolivia. James§ has likened this immense work to the Panama Canal; this joint effort to build a system of highways and connections some 15,000 miles in length is a proof of collaboration on the Continent. During the war the Highway played a vital part in the "battle for raw materials."

It is believed that in future transport over the Highway will be an important trade factor, and James estimated that in 1942 there were about 10,000 oil-engined vehicles in the Western Hemisphere, about half of them in South and Central America. Peru and Bolivia have stepped up auxiliary road construction, a 350-mile highway linking Lima, Peru, with Tingo Maria, site of a new agricultural experiment station. The terminus of this road is Pucallpa, on the Ucayali River; river boats connect with Iquitos at the headwaters of the Amazon.

Reference to the map will show that the South American section of the Highway between La Guaira, Venezuela, and Rio de Janeiro, Brazil, is about 8200 miles long; for the greater part of its length, it follows the Pacific coast through Colombia, Ecuador and Peru, continuing south-east through Bolivia and Argentina. Thereafter it travels northward along the Atlantic coast, through Uruguay and Brazil. It is about 325 miles longer from the junction point at Vitor, Peru, by the western route, which continues south through Chile and eastward to Argentina. From April to November, James states that winter snows accumulate and prevent wheeled traffic through the Uspallata Pass, 12,600ft above sea level in the Andes, along the border between Chile and Argentina. The alternative central route north of Buenos Aires to La Paz, Bolivia, is of paramount importance therefore, because it can be used to connect Argentina, Uruguay, Paraguay, Bolivia and portions of southern Brazil, during the winter months. Several new projects for additional "all-weather" routes are constantly being studied.

In compiling these notes, the author has received much help from Mr. G. H. M. Farley, B.Sc., Acting Secretary of the Tin Research Institute.

Parsons: The Man and His Work*

By Sir CLAUDE D. GIBB, C.B.E., M.E., M.I. Mech. E., F.R.S. (Vice-President)†

Parsons: The Man.—What kind of man was Parsons? Can words convey a true picture? He had Irish blood in his veins and was therefore lovable although often difficult. Possessing a considerable sense of humour and fond of telling anecdotes, he could be a fascinating and charming host entirely considerate of his guests, but could also be quite unreasonably irritating and irascible. Innumerable tales could be told of his interest in and kindness to employees who were ill or had family troubles, and of the scores of times he gave financial assistance without expecting repayment. He was always much more tolerant to juniors than to seniors, and it was often said, "The nearer the top the nearer the gate." A few very senior officials were summarily dismissed, and, as a result, his Irish temper became more legendary than real. The examples of his kindness far outnumber those of his temper, but his reprimands could leave a man shaking badly and not likely to forget the occasion. In the closing years of his life he had mellowed a lot, and his encouragement to the younger members of the staff became treasured memories. Well remembered is the occasion when he said, "If, in your development, you come to a stone wall, don't try to batter your head through it. There is always a way over the top or underneath or around the ends of it." And, again, "If your development has been carried out step by step and always properly analysed, then when you come to a big jump into the unknown, courage and your earlier work will take you safely over." How many times he had proved the truth of those remarks in his own life!

Many were the occasions in his latter years when younger members of his staff made suggestions which appeared to be original and appropriate to the problem of the moment, only to be told to look up some patent specification of probably thirty years earlier which covered that very point. The advanced thinking of Parsons between 1884 and 1910 was quite amazing. In truth, one can say he was at least twenty-five years ahead of his time.

Parsons' great interests were always more in the technical field than in finance. From the creation of Heaton works in 1889 until it was formed into a private limited company in 1913, there appears to be no record of Sir Charles ever having drawn any money from the works for his own purposes, and the company was entirely built up out of the profits of the business. On one occasion, however, he went to his cashier to "borrow" £10, which was never paid back. It was only after the private limited company was formed that he even drew dividends, but otherwise profits—if there were any—were always left in the business and used for further development.

Parsons, as an employer, was as advanced in his treatment of staff and workpeople as in his technical outlook. A short time after the formation of the company he set aside a large sum to create a fund for the benefit of employees. Any workman, even a labourer, could receive assistance from this fund, either by way of weekly payment or lump sum. The employees were encouraged to form their own sick benefit fund, and received assistance from the company in its finances. The formation of the company also gave Sir Charles the opportunity to create a share agreement trust, whereby shares were set aside for the benefit of selected employees, the dividends being paid to Parsons until they accumulated to the share par value, when, on application, the transfer of the share to the employee was completed. He believed that employees who had given long and faithful or outstanding service to him should have a direct interest in the business, and participate in the profits of the works. Yet he felt that shares in the company would be valued all the more if they had to be paid for by accrued dividends.

Parsons displayed only a minor interest in politics, and there appears to be no record of his having expressed views on any of the political questions of his time. He did, however, take a very active interest in social activities connected with his works, and was perfectly happy and thoroughly at home at works concerts, sports meetings, annual dinners, &c.

Parsons was a terrific worker, and in the early stages of turbine development would frequently work far into the night in his private workshop, using his great personal skill as a craftsman in tackling the many problems which were arising daily. After being all day at the works, he would settle down after dinner to several hours' reading of reports or patent specifications. For many years this after-dinner reading would be in his study, in the company of his white sulphur-crested cockatoo, of which he was very fond. This cockatoo, when being chased by rooks, was rescued by Sir Charles near his country home in Northumberland, and, as there was no response to advertisements, was kept as a member of the family, travelling between London and Northumberland according to where Sir Charles and Lady Parsons were living. Sir Charles often opened the door of the cage and the cockatoo—fortunately a well-behaved bird—would follow the party into dinner, and, clambering on to the dining table, would nibble off any plate he fancied. Sir Charles always gave the bird some of his coffee sugar, which was greatly enjoyed.

Parsons was very fond of fishing; in fact, this was his favourite pastime. He also enjoyed shooting, though in this his pleasure seemed to be mainly in the enjoyment the birds gave to his guests in the butts. It is said, by those who knew him most intimately, that it was afloat in a fishing punt on a Northumbrian lake that Parsons was the most wonderful companion.

Formality and anything approaching fuss was distasteful to him, and it is credibly reported that, when attending the World Power Conference in Berlin during 1930 as President of the Engineering Section, he was invited to attend and sign the Golden Book, but his signature was signed on a piece of vellum in his hotel bedroom and afterwards pasted in.

On the Continent of Europe, where formality is more frequently observed than in

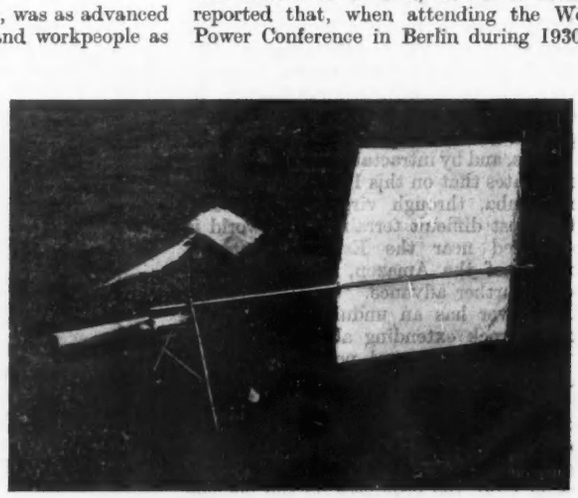


FIG. 1—PARSONS HELICOPTER OF 1893

§ "The Pan-American Highway," by Edwin W. James, in *The Explosives Engineer* for December, 1942.

* Parsons Memorial Lecture, Institution of Mechanical Engineers, June 12th. Abridged.

† Chairman and Managing Director, C. A. Parsons and Co., Ltd., Newcastle-upon-Tyne.

England, he was always known as "Parsons," without prefix or suffix. The late Sir Alfred Yarrow paid a great tribute when in the course of a speech he said that he referred to Sir Charles Parsons as "Parsons," just as one would refer to Shakespeare or Watt, Lister, and others of such eminent standing. Certain it is that Parsons can rank with Watt, and the founder of our Institution, George Stephenson.

In 1881 when Parsons was twenty-seven years old, he established with Sir James Kitson a small experimental workshop at Leeds, where work on the rocket propulsion of torpedoes was carried out for two years. It is amazing that the difficulties in rocket propulsion, which led to its abandonment by

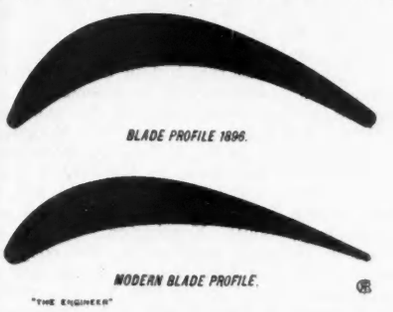


FIG. 2—COMPARISON OF OLD AND MODERN BLADE PROFILES

Parsons in 1883 were still being experienced in 1939 and 1940 by the British team of scientists who ultimately made the rocket such a fearsome weapon of war. Had the specially developed rocket propellant of 1944 been available to Parsons sixty years earlier his thought might not have been diverted to the turbine, with its problems which had been awaiting solution for 1900 years.

From the outset, Parsons realised that if the turbine was to be a success, it must rotate at what in those days were phenomenally high speeds. He and his partners saw a suitable opportunity for the turbine in driving electric generators. The few dynamos which had then been built were, however, of the slow-speed type, suitable for belt drive from reciprocating steam engines, and quite useless for the speeds Parsons knew were essential for the turbine. Hence, in addition to designing a revolutionary form of high-speed prime mover—the turbine—he must also produce an almost equally revolutionary d.c. electrical generator. His first unit generated 10 electrical horsepower and ran at the then unheard-of speed of 18,000 r.p.m. In Parsons' own words, "the efficiency of this dynamo was about 80 per cent, and the steam consumption of the plant about 150 lb per kilowatt-hour. This little turbo worked satisfactorily from the start."

Parsons: His Works.—In 1889, when he was 35 years old, Parsons founded Heaton works, about 2 miles east of Newcastle-upon-Tyne centre. The site, leased from the City Corporation, was about 2 acres, and the single workshop measured 170ft by 50ft. The entire staff numbered forty-eight persons.

The problems and disappointments arising from the rapid development of an entirely new form of prime mover, together with the establishment of a new works, would have been quite enough for most men, yet it was during this period that Parsons—almost as a sideline, it would appear—turned his attention to aeronautics and to ship propulsion. It is generally thought that the first power-driven aeroplane or aeroplane model was built by Langley in America in 1896, yet in 1893 Parsons designed and constructed a power-driven aeroplane which was successfully flown in the garden of his home. Photographs of this model in flight were taken at the time by the late Dr. Gerald Stoney, and an account of it was published in *Nature*, June, 1896. The engine developed about ¼ h.p. at a speed of about 1200 r.p.m. The total area of the wings and tail was about 22 square feet, and it weighed 3¼ lb. The same engine had previously been used in another model, designed on the helicopter principle, and this was found to raise itself vertically from the ground. A reproduction of this aeroplane is in the Science Museum, South Kensington. Fig. 1 shows the helicopter version.

The versatility of Parsons was quite extraordinary, but it was always in the turbine and its development that his main and continued interest lay. His instinctive knowledge on turbine problems was never more displayed than in 1896, when blade profiles and their effect on turbine efficiency were under discussion. On the back of an envelope Parsons sketched an aerofoil-shaped blade which he stated would have the highest intrinsic efficiency. Although there was then no experimental data to support Parsons' belief in his blade sketch, it was adopted as the standard blade profile, and, except for minor modifications, remained so for nearly forty years. This may sound fantastic in these days of rapid progress and large-scale research, yet scores of thousands of pounds were spent by a team of scientists working continuously year after year in their endeavours to improve on the 1896 blade. Fig. 2 shows the 1896 blade above the present-day profile, while Fig. 3 depicts them superimposed, showing the small differences in form.

An experimental set of blading of the 1896 profile, but made to 1946 standards of accuracy and finish, was specially made to compare under research control conditions with the 600 series blading now standard in Parsons land turbines. In Fig. 4 are plotted, for the two sets, the curves of efficiency against velocity ratio. Approximately, £100,000 on blading research was spent to gain the small improvement in efficiency the 600 series blading gives over the 1896 form. What greater example of genius could be given? Yet, although that is probably the outstanding example, there were scores of others.

In 1891, when a turbine accidentally overspeeded, the last disc on the shaft was found

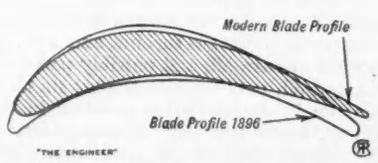


FIG. 3—OLD AND MODERN BLADE PROFILES (SUPERIMPOSED)

to be loose on subsequent examination. Parsons arranged for the bore to be lightly skimmed, since it had stretched, and it was then bushed and again shrunk on to the shaft. On running the turbine to speed again after this, the governing again failed and a similar degree of overspeed was reached, but this time the disc did not come loose. His inquiring mind soon determined the reason, which was that the stress reached in the bore of the disc during overspeed had been sufficiently high to cause plastic flow of the material, whereas the rim stress had not reached that stage, and thus the rim had been put into tension whilst the bore was put into compression by the rim hoop stress.

Parsons realised that by deliberately overspeeding every disc prior to its being shrunk on to the shaft, the margin of safety or the degree of overspeed before a disc came loose was thereby increased. The practice of overspeeding every disc was therefore immediately adopted as standard from 1891 on. It is of interest to note that a precisely similar technique was "invented" in Switzerland in 1927 and patented at that time. About the same period, the practice of stretching the bore of a gun barrel by hydraulic pressure, without taking the outer periphery beyond its yield point, was

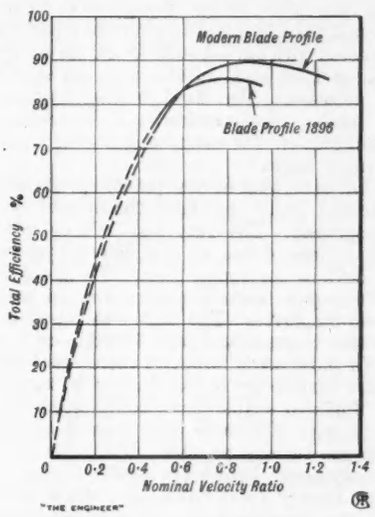


FIG. 4—CURVES OF TOTAL EFFICIENCY AND NOMINAL VELOCITY RATIO

developed and adopted by Ordnance designers, the process being given the name "auto-frettage." It is of interest to note that there is not a single case on record of a turbine disc built by Parsons ever having come loose in service.

Parsons and the Gas Turbine.—Just as only a few people knew that Parsons had flown a power-driven model aeroplane about three years earlier than Langley, to whom the credit generally is given for the first power flight, so it is hardly known that the present-day internal combustion or gas turbine was described by Parsons over sixty-three years ago.

In his famous specification, No. 6735, dated April, 1884, Parsons described the principles of his pressure-compounded reaction steam turbine. But the specification also includes the following clause, which, in the light of our present-day knowledge, can only be read with amazement:—

"Motors according to my invention are applicable to a variety of purposes, and if such an apparatus be driven it becomes a pump and can be used for actuating a fluid column or producing pressure in a fluid. Such a fluid pressure producer can be combined with a multiple motor, according to my invention, to obtain motive power from fuel or combustible gases of any kind. For this purpose I employ the pressure producer to force air or combustible gases into a furnace (into which there may or may not be introduced other fuel, liquid or solid). From the furnace the products of combustion can be led in a heated state to the multiple motor, which they will actuate. Conveniently the pressure producer and multiple motor can be mounted on the same shaft, the former to be driven by the latter, but I do not confine myself to this arrangement of parts. In some cases I employ water or other fluid to

cool the blades, either by conduction of heat through their roots or by other suitable arrangements to effect their protection."

Almost certainly that statement of 1884 laid down the first rational conception of a gas turbine as we to-day interpret the name. But it also foreshadowed the axial-flow compressor which, in effect, is a reversed axial-flow reaction turbine. In 1901, in patent No. 3060, entitled "Improvements in Compressor and Pumps of the Turbine Type," Parsons states, "My invention consists in a compressor or pump of the turbine type operating by the motion of sets of movable vanes or blades between sets of fixed blades, the movable blades being more widely spaced than in my steam turbines, and constructed with curved surfaces on the delivery side and set at a suitable angle to the axis of rotation. The fixed blades may have a similar configuration and be similarly arranged on the containing casing at any suitable angle."

The same year as that patent specification, Parsons built the first commercial axial compressor. The duty was 3000 cubic feet per minute of free air at a delivery pressure of 1·75 lb per square inch. Its speed was 4000 r.p.m. and nineteen pressure stages were employed. The unit was supplied to Messrs. Cookson and Sons, Howdon-on-Tyne.

In those days, however, there was insufficient knowledge of the theory of the flow of fluids to enable those compressors to be built with efficiencies high enough to make the gas turbine possible. The advances in aerodynamic knowledge made during the past twenty years have contributed mainly to the improvement in axial-compressor efficiency from about 60 per cent to the present-day 84 to 86 per cent. This advance, coupled with great improvements in materials able to withstand high stresses combined with high temperatures, has made possible the modern gas turbine.

Parsons often referred to the possibilities of the gas turbine in papers he wrote and in discussions with his staff and friends, but it was not until 1929 that he began seriously to examine the factors necessary to produce a successful unit. He had long realised the necessity for high temperatures at the gas turbine inlet, and for higher efficiencies in the compressor than were possible at that date.

Consideration was being given at the same period to raising initial temperatures in the steam turbine to 1000 deg. Fah., and erosion on the first row of blades had been suggested as a likely result of such highly superheated steam. Parsons was confident that there was no likelihood of such an effect, and determined to carry out tests with the dual object of killing the erosion bogey and ascertaining the behaviour of materials at an operating temperature of 1000 deg. Fah.

An ingenious superheater was built, in which a long steel tube was coiled to form the low-tension secondary winding of a transformer, the primary of which was connected to a variable-voltage a.c. supply. Heavy current, at only 6V to 12V, was induced in the coiled tube, through which high-pressure steam was passed to cool the tube and raise the steam at the outlet to over 1000 deg. Fah. This highly superheated steam was played at high velocity on to blading specimens of different materials for long periods.

These tests gave no support to the suggestion that erosion of blading would be a problem of importance in either high-temperature steam turbines or in the gas turbine then under consideration. The tests also indicated that operating temperatures of 1000 deg. Fah. were not impossible with the best materials then available.

There remained, however, the problem of compressor efficiencies, and this was next tackled. The late Dr. Robert Dowson, then chief research engineer, readily convinced Parsons that the axial-flow compressor offered great scope for development, and work commenced on the improvement of both the axial-flow and the centrifugal compressor. With the application of the aerodynamic theory, originally propounded by Lanchester, rapid advances were made.

Early in 1931 Parsons left England with Lady Parsons on the "Duchess of Richmond," to visit the West Indies. During that voyage developed his illness which proved fatal on February 11, 1931, when he was in his seventy-seventh year. Before leaving Heaton works to begin what was to be his last voyage, Parsons was discussing future research work with Dr. Dowson, and remarked that he thought he had the solution to the gas turbine problem, and that he would work out the details during the voyage. We shall never know what he had in mind, but it is likely that under the stimulus of such a genius even greater progress might have been made.

Work on the gas turbine problem continued after his death, and by 1938 axial-flow compressor efficiencies of over 80 per cent were being obtained, making the gas turbine a practical possibility.

It is a matter of some difficulty, at the present stage of its development, to foresee the ultimate place of the gas turbine in the power field. In comparison with the steam turbine, it has much in its favour. The high operating temperatures which are its very life blood are—at least in the open cycle—confined to the turbines, to the relatively small combustion chambers, and to the interconnecting piping. With contra-flow intercoolers between compression stages, the cooling water need be but a fracton of that necessary for a modern steam plant. As against some 30,000kW per acre for a steam installation, we should be able to obtain over 100,000kW of open-cycle gas turbine plant within the same area. Overall efficiencies may be expected to equal and often exceed those obtainable from modern high-efficiency steam plants.

Such factors as initial and annual running costs and reliability decide each instance investigated. Only operating experience enables manufacturers and users to establish these all-important matters. Conditions are favourable to the economical and efficient development of the gas turbine, and although the need to burn oil, and possibly particular grades of oil, may militate against its large-scale use in central power stations in this country, there are, nevertheless, plenty of installations, both in this and other fields, at home and abroad, where it will prove a sound and economical investment.

British engineers have gained world supremacy in aircraft applications of the gas turbines, and British turbine builders, if given the opportunity, can obtain the same supremacy for British engineering in the industrial field. It is therefore incumbent upon all who have our national economy and welfare at heart to ensure that such opportunities are provided.

Ten years ago the relative prices of coal and oil were such that the gas turbine would have had little opportunity of competing with coal-fired boilers and steam turbines, but the economics of power generation have changed and are still changing rapidly, and in the few years which must inevitably elapse before large-size British gas turbines can be put into regular operation, the economics of fuel supply may well change in favour of the gas turbine.

International Congress of Pure and Applied Chemistry

THE 11th International Congress of Pure and Applied Chemistry is to be held in London from Thursday, July 17th to Thursday, July 24th, 1947, immediately following the Centenary of the Chemical Society. The congress is being held under the patronage of H.M. the King, and the President is Lord Leverhulme. A distinguished executive committee has been formed under the chairmanship of Dr. L. H. Lampitt, the President of the Society of Chemical Industry. Delegates to the congress are expected to number more than 2000 from at least twenty-four different countries. The congress will be opened by an address by the president and the closing session will consist of a lecture by Sir Robert Robinson, the president of the Royal Society. Both these meetings will take place at the Central Hall, Westminster, but all other sessions will be held at the Imperial College of Science and Technology, South Kensington. There are fourteen different sections of the congress, some of which will be of particular interest to engineers. Thus, in Section 9, "Chemistry in Relation to Fuel, Power and Transport" will be discussed, and papers will be read and discussed at a series of symposia. On Friday and Saturday, July 18th and 19th, the title of the symposium is "Liquid Fuels and other Products from Petroleum, and Coal." In this symposium Dr. Howes and Mr. H. C. Rampton, of the Anglo-Iranian Oil Company, Ltd., will present a paper on "The Properties of Hydrocarbon Fuels for Gas Turbines." On Saturday morning Sir Ernest Smith gives an address on "The Training of Chemists for the Fuel Industries." On Monday, July 21st, the symposium will be on "Characteristics of Solid Fuels" on Tuesday, on "Carbonisation and Gasification," and on Wednesday, on "Combustion." Seven to nine papers will be presented in each of the symposiums.

British Standards Institution

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria Street, London, S.W.1. The price of each specification is 2s. 3d. post free, unless otherwise stated.

TESTS FOR USE IN TRAINING OF WELDERS

B.S. No. 1295 : 1946. This standard has been prepared in an endeavour to unify the general method of assessing the quality of workmanship of a welder during his period of training. It is appreciated that the conditions under which welders are trained in the various schools set up throughout the country naturally vary to a considerable extent. Consequently, there has been a corresponding variation in the methods adopted for assessing workmanship, and the need was felt for test methods which would assist in securing that the work of all welding trainees should be judged by similar means, thus leading to a uniform standard of training in all schools. The tests are not intended to rank as an indication of the capacity of a trainee to conform to the requirements of any other British standard specification for a particular job where tests of workmanship under special conditions are required, but should only be used as a guide to instructors in assisting them to assess the progress of individual trainees. The standard lays down the general requirements in regard to types of material, preparatory work, simulation to actual work, and testing procedure for a series of tests designed to assess the quality of workmanship of a welder during his period of training. Two schedules list the various aspects of welds for which test specimens should be inspected. There are nine tests covering butt welds in plates and piping, fillet welds in plates and sheets, pipe branch welds and the building-up of surfaces. Appendices deal with a suggested method of preparing etched specimens and give notes for the guidance of instructors. Copies of this standard may be obtained from the Publications Department, British Standards Institution, 28, Victoria Street, S.W.1, price 3s. 6d. post free.

Radio Relay Link for Television

WIDE-BAND radio communication in general and television and telephony in particular are likely to benefit substantially from recent progress in applying radar technique to the design of very high frequency radio links. Generally, the use of v.h.f. radio links offers a promising solution to the problems of providing multi-channel communication, in a form that rivals land-lines or cables. In particular, television is in a position to gain because its growth is restricted by the fact that reception in this country is, at present, limited to an area lying within a radius of some twenty-five miles of Alexandra Palace. Apart from the transmission of independent programmes, the immediate prospects of extending television reception to other parts of the country depend upon the installation of radio links, whereby the Alexandra Palace programmes can be relayed and retransmitted through one or more intermediate stations over a wide area.

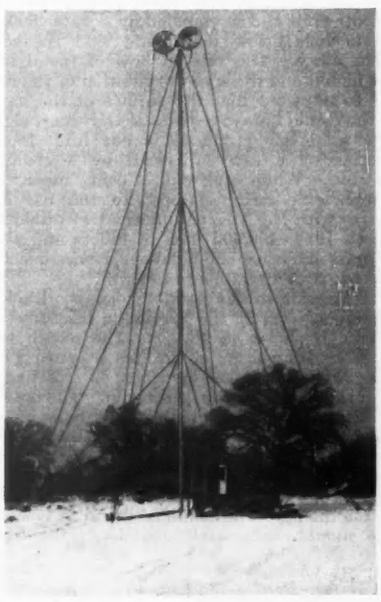
An important advance in the growth of television broadcasting is therefore foreshadowed in the recent announcement that the General Electric Company, Ltd., Magnet House, Kingsway, London, W.C.2, will design and supply to the G.P.O. a radio relay link between London and Birmingham. This link is intended for the transmission of television signals having the waveform of the present 405 line, 50 frames per second, signals transmitted by the B.B.C. from Alexandra Palace. When completed, the link will permit television signals to be relayed simultaneously from London to Birmingham and from Birmingham to London, but in order to establish a link between the two cities at the earliest possible moment a single reversible channel will first be installed. The system is being designed so as to be suitable for later extension, if this should be decided upon, and for continuous operation. Transmission is to take place between a radio terminal near London and a radio terminal near Birmingham, and facilities for monitoring and control of all the equipment used in the link are to be concentrated at two control points, one in each city.

The radio frequencies used will be of the order of 1000 Mc/s, the system being designed for operation over optical paths between stations up to forty miles apart. Two intermediate stations will be used to relay the signals between the radio terminals and because of the nature of the terrain, one path will be about twenty miles in length, and each of the other two will be about forty miles. At each station there will be a lattice steel tower of the order of 80ft high, which will carry a cabin 9ft square, containing the radio-frequency and signal channel equipment and outside which the transmitting and receiving aerial systems, each approximately 12ft in diameter, will be mounted. At the foot of the tower there will be a small building to contain the power supply units for the signal channels, the supervisory control equipment and a standby power generator. Attention has been given to the maintenance of service from the system in all weather conditions; temperature and humidity control will be applied to the cabin and building, and an automatic de-icing system to the aerial structures.

The system has been developed round a series of Osram disc-seal triodes (including the ACT22 and ACT23), which have been specially designed for use in coaxial-line and resonator circuits, and which are used as the radio-frequency oscillators and amplifiers at each station. The London-Birmingham link will use a total of four transmitter frequencies, but these same four frequencies can be used over and over again in the extension of the system; special precautions will be taken to avoid any drift in transmitted frequency. The receivers will be of the superheterodyne type, but by a special modulation technique video-frequency signals will not appear except at the input and output of the system at the radio terminals.

All equipment, except the aerial systems, in each channel at a station will be duplicated and the standby equipment will automatically come into service immediately upon the event of a failure in the working equipment. In the event of such a failure, the aerial systems will be automatically switched from the working to the standby equipment, by radio-frequency contactless switches. The equipment in each channel will be controlled from the control point at the receiving end of the link and from this control point it will be possible to switch on or off the complete channel, or any one station equipment by a single operation. It will also be possible to change over from the working to the standby equipments, individually or collectively.

The complete state of a channel will be displayed on a special indicator board at the appropriate control point and it will be possible to see which equipment, power supply unit and system of power supply are in use at each station. Any failure at a station will cause



PORTABLE MAST AND MOBILE STATION

an alarm to be sounded at the control point; the failure and the subsequent automatic changeover to the standby plant will be displayed on the indicator board. Interlocks will be provided to prevent any equipment being switched back into service after a fault has occurred in it. Each unit at the stations will have fault indicators for the rapid location of faults by visiting maintenance engineers. All the radio stations will be unmanned, so that it should not be necessary for them to be visited more than once a month.

The sites for all four stations must be chosen very carefully, to ensure satisfactory operation of the link without impairing local amenities. Before a site can be finally decided on, extensive field trials must be carried out and for this purpose two vehicles have been equipped as mobile laboratories, each containing a transmitter, a receiver, measuring apparatus and its own power supply generator. Field trials were carried out over possible routes, using these vehicles and portable masts for supporting the aerial systems, as depicted in the accompanying engraving, and the trials have shown that steady and consistent signals can be obtained. Trials were also carried out to determine the effect on the signal strength of an aircraft flying in or close to the beam, and it was found that the proposed gain control of the system would reduce such interference to a negligible amount.

The installation of the radio link, as has been stated, is to take place in two parts and initially a single channel, with its standby equipment, will be installed. The direction of transmission of this channel, which comprises one of the two sets of equipment to be used in the final scheme, will be reversible, so that at any time it will be possible to transmit signals from Birmingham to London or from London to Birmingham. For this initial stage the aerial systems will be mounted on temporary structures on the same sites that will be used for the complete scheme. Subsequently the second channel will be installed in its final position and then the original channel will be moved to its own final position and it will then be possible to have simultaneous transmission in the two directions.

Intensive work on the development of v.h.f. frequency modulated radio links is also being done by Marconi's Wireless Telegraph Company, Ltd., Chelmsford, Essex. The progress made was illustrated very strikingly at a recent demonstration given by the Marconi Company to show the quality of the relayed transmission and to indicate the future possibilities of the system. For the purpose of this demonstration, a re-transmitting station was set up on Danbury Hill, near Chelmsford. Here, at a distance of 31½ miles from Alexandra Palace, transmissions are picked up from the London Television station and relayed to Great Bromley (six miles east of Colchester), a further distance of twenty-four miles. In two stages, therefore, the transmission is relayed a total distance of 55½ miles.

Briefly, in the vision receiver at the relay point, Danbury, normal television receiver technique is employed, since the signal received direct from Alexandra Palace is within optical range at Danbury. The received vision signal is then used to modulate a 60cm (510 Mc/s) transmitter, by means of frequency modulation, the output being fed into a horn-shaped transmitting aerial. Both receiving and transmitting aerials are mounted on a lattice mast, at a height of 40ft above ground level. The transmitter aerial at Danbury re-radiates the vision signal in a narrow directional beam to the second station at Great Bromley.

At Great Bromley the beamed signals are picked up by a directional aerial in the form of a parabola. This aerial is mounted at a height of 200ft on a disused radar tower. For reasons of efficiency, the 60cm receiver is placed near the aerial, and its output is taken by cable down the mast into a hut where the received image is shown on a receiver using normal technique. Sound is re-transmitted in a similar fashion through the relay chain except that the wavelengths used for sound differ slightly from those used on vision transmission.

The demonstration that we witnessed made use of the normal afternoon transmission from Alexandra Palace and the programme consisted of scenes from the race-course at Ascot. On this occasion the received image was of a quality that could not be distinguished from that normally obtainable by direct transmission and there was no evidence of increased interference.

CONTROL OF MINERAL WORKING.—The Ministry of Town and Country Planning has drawn attention to the provision made under the Town and Country Planning (General Interim Development) Order, 1946, whereby existing quarries which have not already received interim development permission are authorised to continue working in a normal manner until June 30, 1947. It is explained that progress has been made with settling the future of existing quarries, but that many cases still remain to be dealt with. As it is necessary to avoid interruption of essential production, the Minister has decided to amend the Order, so as to permit the continued working of existing quarries which have not received permission for a further six months beyond June 30th.

Metallurgical Topics

Continuous Casting

THE text has just appeared of a paper by Dr. Hermann Kästner[1] on the "Development and Present Position of the Continuous Casting of Non-Ferrous Metals," presented at a meeting of the Verein Deutscher Eisenhüttenleute in July, 1944, that is a few months after a symposium on continuous casting[2] had been held in New York in February, 1944.

Dr. Kästner's object was to arouse the interest of the steelmakers in a casting process

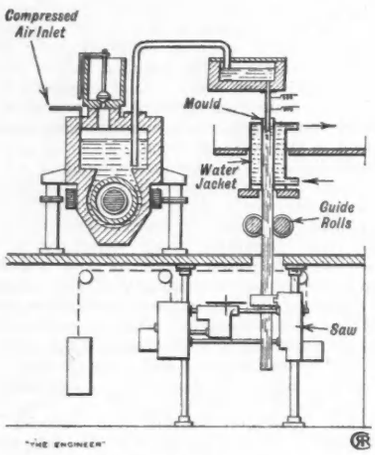


FIG. 1—*First Design of Fully Continuous Casting Plant* (1933)

which the non-ferrous industry had developed for copper alloys, zinc and magnesium alloys, and above all for the alloys of aluminium, and to indicate the promise of the advantage which might accrue from the successful employment of the process in the steelworks.

The first part of the paper consists of a historical review of the part played by the pioneers of the process in Germany, *viz.*, Wieland-Werke A.G., Siegfried Junghans, and Vereinigte Leichtmetall-Werke G.m.b.H., in the development of the technique of continuous casting as now employed.

Until shortly after the first world war the

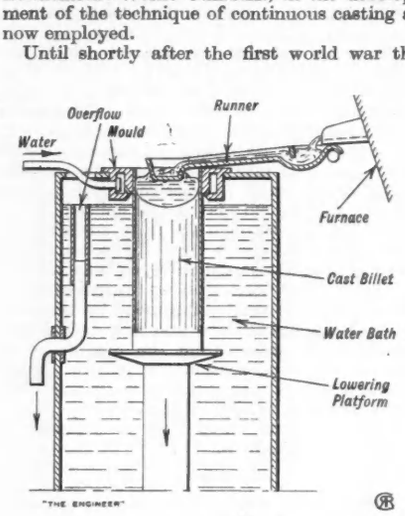


FIG. 2—*Semi-Continuous Casting Plant (Water Cast)*

non-ferrous heavy metals were cast in uncooled vertical sand or iron moulds. The nineteen-twenties saw the introduction of the water-cooled mould and of tilting combinations of crucible and mould, which found wide application in the casting of light alloys.

The first commercially successful equipment for the continuous casting of brass was completed at the Wieland-Werke under the guidance of Siegfried Junghans in 1933, and worked without any fundamental change or interruption until nearly the end of the war. A diagram of this plant is shown in Fig. 1. The liquid metal, melted in a low-frequency induction furnace, was forced by compressed air or nitrogen into a fixed container situated above the

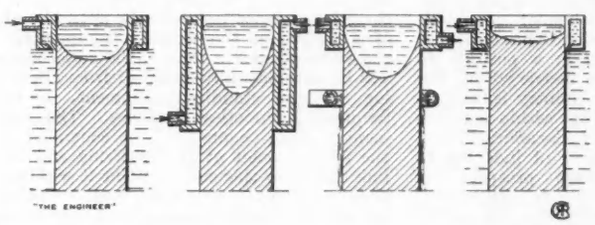


FIG. 3—*Modification of the Water-Casting Process to Avoid the Formation of Cracks.*

mould. From the bottom of this, metal was run into the mould through a tube of refractory material. To restrict flow, the outlet of the tube was tapered to a nozzle which dipped below the surface of the metal in the mould, so that molten metal did not come into contact with the air.

The mould consists of a copper tube open at both ends and surrounded by a water jacket. Guide rolls below the mould lead the solid billet away. The rate of flow of metal into the mould and the speed of rotation of the rolls are so adjusted that the surface of the metal in the mould always remains at the same height. The solid bar produced is cut into desired lengths by a saw supported by a counter-weight. While each cut is being made, the saw is temporarily clamped to the bar and moves with it. This equipment had produced, up to 1944, 100,000 tons of billets and slabs of brass and other copper alloys, having reached an output of 1700 tons in a month.

A diagram of the plant for semi-continuous casting as used by the Vereinigte Leichtmetall-Werke is shown in Fig. 2. The metal flows from a tilting furnace, through a pouring box and along a channel by which it is delivered to a shallow, water-cooled mould. The bottom of the mould is first closed with a stopper resting on a hydraulically operated platform. The rate of feeding metal into the mould and of lowering the platform are so adjusted that the surface of the metal is always at the same height in the mould. The solidified metal as it leaves the mould finds itself completely immersed

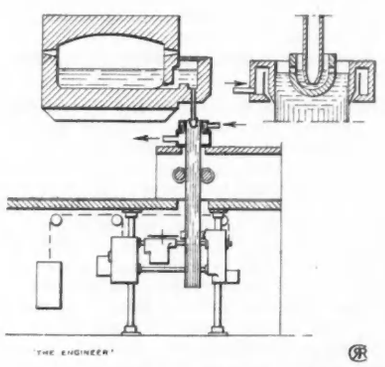


FIG. 4—*Continuous Casting Plant* (1936)

in water. When the platform has reached its lowest position the casting process is interrupted, the cast metal removed and the process started again.

The idea of feeding molten metal at constant temperature into a mould, the bottom of which is closed by solidified metal, while at the same time withdrawing the solid product so that the surface of the metal in the mould is always at the same height, is realised in both the above processes, but the important metallurgical difference lies in the manner of removal of heat.

During solidification of metal in an ordinary mould the heat escapes mainly through the sides of the mould, and the metal remains fluid longest at the centre and towards the top of the mould. If the heat is abstracted through the bottom of the mould only, the surface of solidification is almost horizontal. This difference in direction of solidification has important effects in increasing the soundness and reducing inverse segregation. Dr. Kästner deals with this effect on the basis of the work of P. Brenner and W. Roth[3] of the Research Laboratories of Vereinigte Leichtmetall-Werke.

In continuous casting a considerable percentage of the total heat is conducted away through the solidified metal, *i.e.*, through the effective bottom of the mould. This is specially so in the method used by the Vereinigte Leichtmetall-Werke (Fig. 2), in which the short mould and the intensive water cooling of the solid metal combine to make the solidifying surface almost horizontal. On the other hand, the abrupt cooling may induce in some alloys high shrinkage stresses tending to give rise to internal cracks. To obtain ingots free from

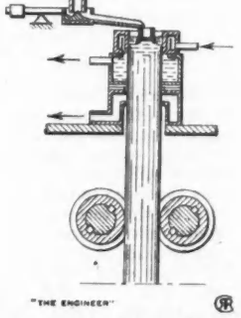


FIG. 5—*Continuous Casting Plant (Modified Runner).*

cracks it is important to select conditions such that the metal is solid throughout the whole of its cross-section before it reaches a region of intensive cooling. This, as is shown in Fig. 3, can be done in various ways. The first diagram indicates the condition to be avoided; the others the means taken to avoid it. Either there may be a long mould without any direct cooling, or a short mould succeeded by exposure to air over a short distance, followed by cooling in a water spray, or, finally, a short mould followed immediately by direct water-cooling but with the casting velocity so reduced that the ingot is solid throughout its section before it reaches the region of direct cooling. The necessary reduction in the rate of pouring, however, leads to diminished production and the highest output can only be obtained by simultaneous casting in several moulds.

Both in the semi-continuous and in the continuous process it is possible to cast several ingots at a time. In the semi-continuous process six circular moulds may be used for casting bars supported on a common moving

platform. In the fully continuous process moulds may be set side by side and operated simultaneously as in the plant for the continuous casting of aluminium alloys installed in 1936 in the Wieland-Werke (Fig. 4). The metal is not forced out under pressure but is delivered from a fore-hearth separated from the furnace by a diaphragm of refractory material, which keeps back the scum, through a refractory tube into a distributing vessel of graphite, from which it flows without turbulence into the mould. Later on the components of the multiple casting equipment were reconstructed, as shown in Fig. 5, the essential difference being in the method of control of the flow of metal by the provision of an adjustable graphite stopper to the down-runner from the fore-hearth. Details of the rolls and saw remain the same as in Fig. 1; the number of castings was limited only by the stroke of the saw. Photographs of the equipment for casting round bars and rectangular slabs are given in the paper, and one of them is reproduced in Fig. 6. To the question as to whether the fully continuous or the semi-continuous method of casting is preferable no general answer can be given. To meet a constant demand for a large amount of the same alloy, the fully continuous process is best, but if the requirement is for a variety of materials, or for an alloy which is difficult to saw into lengths, the semi-continuous process would possess the advantage.

FIG. 6—*Simultaneous Casting of Five 150mm Diameter Round Bars*

The cast material, both aluminium alloys and brass, is characterised by soundness, uniformity of grain size, and freedom from pipe, cavities and segregation. The development work carried out by Siegfried Junghans has enabled the continuously cast products to be rolled hot as they cool from the casting temperature, and this is stated to have been done with good results since 1939.

Many difficulties were encountered in the application of the process to the production of hollow bars or tubes. Water-cooled mandrels of copper or other high-conductivity material are employed, having a length not greater, and usually considerably less, than that of the mould (Fig. 7). The construction of the mandrel is essentially the same as that of the mould. The danger of shrinkage of the solidifying metal on to the mandrel is overcome by making the jacket face parabolic, but conical mandrels have been used with good results. For many purposes uncooled mandrels appear to be advantageous but their development is not yet complete.

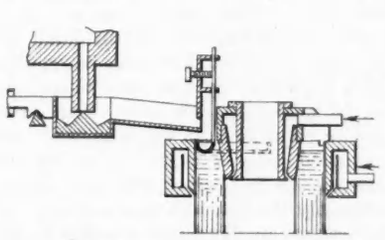


FIG. 7—*Equipment for Casting Tubes*

Dr. Kästner, in accordance with the main object of his paper, discusses in some detail the possibility of success in the continuous casting of iron and steel, putting forward the following considerations:—

(1) The melting and casting temperatures of steel and iron are considerably higher than those of the non-ferrous metals hitherto cast.

(2) The total heat given out is very large.

(3) Thermal conductivity in steel and iron is considerably lower than in most non-ferrous metals.

(4) The considerable amount of slag formed gives rise to casting difficulties.

(5) The iron and steel manufacturer is accustomed to deal with a much higher output than are those concerned with the production of heavy and light non-ferrous alloys.

On the other hand he indicates that the total heat evolved per unit mass in cooling from the casting temperature to 20 deg. Cent. is nearly as much for aluminium as for cast iron (263 and 283 kcal/kg, respectively), and the comparison is even more favourable if steel, cooled to some intermediate temperature, *e.g.*, to a forging heat, is considered. Thus, in cooling from 1600 deg. to 1000 deg. Cent. the heat evolved, 173·5 kcal/kg, is much less than the 263 kcal/kg given out by aluminium in cooling from 700 deg. Cent. to room temperature. If heat per unit volume is considered, aluminium has of course a great advantage. A given volume of steel cooling down to 1000 deg. Cent. evolves as much heat as the same volume of brass cooling from its casting temperature to 20 deg. Cent.

In spite of these somewhat unpromising prospects, Dr. Kästner claimed that trials had shown that the application of continuous casting to steel is fundamentally possible, and referred to the significance of the success reported to have been achieved in the United States[1]. The evolution of heat through a longer time and temperature range for steel may be taken care of by correct proportioning of the cooling distance both inside and outside the mould, but effective dissipation of the heat must involve slowing down the rate of casting, with consequent decrease in output, which can only be compensated by increasing the number of casts made simultaneously. The duplication of plant is expensive, necessarily slow working would give increased opportunity for oxidation, the problem of refractory tubes for continuous operation still offers difficulty, but nevertheless, Dr. Kästner concludes that if a substantial reduction in the amount of scrap produced can be achieved—and this would be in accordance with non-ferrous experience—continuous casting of steel, in spite of the difficulties associated with it, would be more favourable economically than would appear on the grounds of output obtainable.

Teams visiting Germany have given brief descriptions of continuous casting as applied to brass and to aluminium alloys[5], but there appears to be no evidence that the German steelmakers adopted or had any success with a continuous casting process for steel.

REFERENCES

[1] *Stahl und Eisen*, January 2, 1947 (66th-67th year), pages 10–19.

[2] American Institute of Mining and Metallurgical Engineers, Technical Publication No. 1793, 1944; *Metals Technology*, February, 1945.

[3] *Zeitschrift für Metallkunde*, 1940, Vol. 32, pages 10–14; reviewed in THE METALLURGIST, April 1941, page 9.

[4] T. W. Lippert, *Iron Age*, 1940, Vol. 145, pages 31–39 and 44–47; see also E. R. Williams, *Steel*, 1940, Vol. 106, pages 48–49, 56–58, and 81.

[5] See reports: C.I.O.S. XXX-51 (Wieland-Werke), C.I.O.S. XXXI-73 (Vereinigte Leichtmetall-Werke), and B.I.O.S. 463 (Vereinigte Deutsche Metallwerke).

Cementation by Beryllium

J. LAISSUS, who for more than twenty years has been studying the metallic cementation of iron alloys, often with results of practical interest, has extended his work on the cementation of iron, carbon steels and nickel steels by beryllium* to high chromium and chromium-nickel steels.† The mechanism of diffusion appeared to be similar in both, and was analogous to that in nickel steels, but the depth of the case in 18 : 8 chromium-nickel steel was considerably greater than in the 13 per cent chromium steel, although both were in the austenitic condition at temperatures at which diffusion became appreciable. The principal effect was a considerable, but not outstanding, increase in hardness. Vickers hardness numbers were as follows, the higher values for the 10-kg load being more representative of the surface of the cemented layer.

Vickers Hardness After Cementation for 10 hours

Temperature, deg. Cent.	10-kg load		50-kg load	
	13 Cr	18 : 8	13 Cr	18 : 8
Not cemented ...	—	—	198	195
900	290	334	221	213
1000	642	474	421	263
1100	599	772	511	403
1150	573	670	577	688

It would appear that a much more striking effect, or advantages in other directions, would be required to give cementation by beryllium a practical value.

* *Revue de Métallurgie*, 1935, Vol. 32, page 293 and 351.

† *Comptes rendus*, 1947, Vol. 224, page 742.

Rare Metals During the War

AT a conference held last December by the Liége section of the A.I.Lg., P. Swings and L. de Merre added yet another to the many reviews which have appeared of the scientific and technical achievement of the war period.* The subject-matter was representative of the whole field of scientific development arising from laboratory work, chemical, physical and biological, and included a short reference to a number of metals ranging from those in common use, like iron and aluminium, to the radio-active isotopes and new elements. A few references to metals which are rare in the commercial sense may be noted. The application of many of these is limited by the difficulty of obtaining them in the ductile condition. This applies, for example, to beryllium, titanium and zirconium, the principal applications of which are as alloys.

Beryllium, apart from its use for the windows of X-ray tubes, is best known as an alloying element, giving the hard, wear-resisting copper-beryllium alloys, used for non-sparking tools, worm gears and springs, and a precipitation-hardening variety of austenitic stainless steel, for which there are possible uses. Metallic titanium and zirconium find their main application, when in the form of ferro-alloys, in steel manufacture as scavenging agents or in the case of titanium as an addition to suppress the hardening of weld metal and to prevent inter-crystalline precipitation of carbide in austenitic stainless steel and so remove susceptibility to weld decay.

Of an altogether different type is the element gallium, which melts at a temperature just below 30 deg. Cent., but usually supercools before solidification, so that it is the only metal other than mercury that remains liquid at room temperature. On the other hand, its vapour pressure remains low up to a high temperature. Thermometers in the form of capillary tubes of transparent silica containing gallium were proposed twenty years ago, but manufacture was unsuccessful. Gallium thermometers, which may be used up to 1200 deg. Cent., have been developed in Germany during the war. A detailed description and assessment of the accuracy of these thermometers is to be found in B.I.O.S. Final Report, No. 345.

Germanium has acquired some importance on account of the possible uses of the gold-germanium eutectic, which contains 88 per cent of gold and 12 per cent of germanium. Its melting point is only 355 deg. Cent., and it shows a slight expansion on solidification. It casts well, is harder than many alloys of gold and has been used for certain components of radar equipment. In peacetime it may evidently have applications for jewellery and in dentistry. About a ton of germanium is produced per annum in the United States as a by-product in the extraction of zinc and cadmium.

* P. Swings and L. de Merre: "La Bataille des Laboratoires," *Revue Universelle des Mines*, 1947, 9th Series, Vol. 3, pages 158-191.

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ELECTRONIC ENGINEERING

Morgan Brothers (Publishers), Ltd., Proprietors of THE ENGINEER, THE IRONMONGER and THE CHEMIST AND DRUGGIST, announce that they have acquired the monthly periodical ELECTRONIC ENGINEERING (incorporating Electronics, Television and Short-Wave World) from the present owners, Hulton Press, Ltd.

Morgan Brothers (Publishers) Ltd. will be responsible for the publication of ELECTRONIC ENGINEERING commencing with the August issue. All correspondence after July 1st should, therefore, be addressed to ELECTRONIC ENGINEERING, 28, Essex Street, Strand, London, W.C. 2. The Editor and the Staff will continue to serve the paper under its new proprietorship.

NOTICE TO READERS

All letters intended for insertion in THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.

For Subscription Rates, see page 2 of Advertisements.

Mr. ALDOUS HUXLEY AND APPLIED SCIENCE

APPLIED science has never lacked opponents. Some have assailed it with the tongue, some with the pen, some with the brick and firebrand. But it has continued to go upon its way; doing its little bit of temporary harm; giving a little short-lived inconvenience, but adding always in the end to those things that meet mankind's bodily needs or increase his pleasures. Were it otherwise, were applied science generally inimical to man's contentment, it would not have been tolerated. Even were the examples of its deplorable misapplication more frequent than they are, still would the advantages outweigh the disadvantages, still would mankind demand its services in ever-increasing degree. To imagine a world without applied science is to imagine the incredible; to imagine, as some have done, a world in which applied science had become static is to imagine the impossible.

Amongst its latest critics is Mr. Aldous Huxley, in an essay entitled "Science, Liberty and Peace." His *bête noire* is mass production. "The reason for this dismal state of things," he asserts, after summarising them, "is the progressive application of the results of pure science for the benefit of mass-producing and mass-distributing industry, and with the unconscious or conscious purpose of furthering centralisation of power in finance, manufacture and government." Let it be admitted that the needs of industry—particularly in these days, when full employment is a primary consideration—must be met, yet it remains true that mass production survives because it is the best way of providing the customer at home and overseas with what he wants. Fabrics, to take an instance, could not be woven or motor-cars made in sufficient quantity and at a low enough price by any other method. It is purely a technological problem, and the furthering of the "centralisation of power in finance, manufacture and government" is rarely, if ever, the primary object. Amalgamations and combines may be, perhaps generally are, effected with that as one of their purposes, but in many cases the methods of mass production have preceded such amalgamations. The plain fact is that, in appropriate cases, mass production is the best technology, and if it happens to "centralise power," that is an incident, not the motivation, of its existence. The same is true of mass distribution. The mass distribution of electricity is an example. Does anyone imagine that its first object is to concentrate power in the hands of the Central Electricity Board and not the satisfaction of the public? It is not to be denied that the accumulation of power by private corporations or by Governments may be carried too far, but it is unfair to put the blame on the applications of pure science for their misuse. Mr. Huxley, like many others of the present day, have a horror of power and a dislike of authority put over them. But surely it is not power itself, but how it is used that matters. In mass production and mass distribution the power is ordinarily exerted beneficently. Mr. Huxley's objection to "power" and "bosses" is based on their interference with man's spiritual and psychological needs. It would, perhaps, be not unfair to say that he dislikes the application of science by mass production methods because it is efficient, not because it is applied science.

Whilst we have joined issue with Mr. Huxley on points of fact, we do not deny that in some degree our sympathies draw us to his side. His remedy for the ills he sees is that inventors and technicians should "apply the results of pure science for the purpose of increasing the economic self-sufficiency and consequently the political independence of small owners, working either on their own or in co-operative groups, concerned, not with mass production, but with subsistence and the supply of a local market." The vision of a small, self-contained, self-satisfying community living a peaceful existence, undisturbed by the rattling of the world around it, has inspired many thinkers and a few experiments. Experience has shown that it can only be worked on the smallest scale. Pleasant as the contemplation is of a world in which every man would be exclusive master of his own soul, we have to face the fact that circumstances are driving mankind to ever greater interdependence and to ever greater reliance upon the material things that applied science alone can provide. From that there is no escape. Mr. Huxley's plan does not open a way out. All that can be done, and that perhaps will be done, is to control and direct the ingenuity of scientists and engineers that they may make the bonds of civilisation as little irksome as possible.

LIMITATIONS

TO-DAY we are beset by limitations. Coal and steel are in short supply. Lack of timber holds up more than the construction of houses. Food is scarce and rationed. Electric power is subject to winter "cuts." Labour clings to restrictive practices. Controls, far from becoming fewer seem still to multiply. Restrictions upon every hand affect our capacity to work and to produce. We can find no good word for limitations. We are tempted to draw the sweeping general conclusion that they are always bad. Yet is that generalisation really true? Do we really wish to see all limitations removed? In our engineering work, for instance, we suffer many restrictions. Design and practice is bound and fettered within the limited strengths of materials. It is held down by the need to allow for the effects of thermodynamic laws, of inertia in its various forms, of difficulties of heat transmission and of many other factors, scientific and practical. Are such limitations always bad? Surely not! For how very inefficient and chaotic a world it would be if many of the dreams we set afloat as students had not foundered irredeemably upon just such rocks of natural law and engineering practice, just such limitations!

In truth, the less fettered we are in design the more difficult, not the easier, it becomes. If but a single material is available for a certain purpose we are at once relieved of the responsibility of making a choice between alternatives. Further, we can afford the time to study that material in detail and, becoming wholly familiar with its qualities, use it in such a way that both its strengths and its weaknesses are subtly bent to our purpose. But how can we do as much when a hundred differing materials are offered? How can we feel certain that our choice is necessarily the best and that we have made the best use of the chosen material? How even more complicated and impossible the position becomes when each year new materials with new characteristics are added to the throng. Of the great outpouring annually before our engineering societies of technical papers on this matter and on that how much lies fallow? For on every hand we hear complaint not of a general lack of material but that there is too much! It is impossible to keep pace even in a self-restricted field with the amount of knowledge annually published. In this way we are brought face to face with a limitation

more fundamental than any other. Despite the great weight of human knowledge that has been accumulated across the centuries, despite the complexity of the organisation of modern cities as compared with those of the past, there is no evidence whatever that the minds of modern men are one whit less limited than those of ancient Greeks, Romans or Egyptians. These foreigners, of ancient times, seem, when read about, as ordinarily human as our twentieth century friends familiar to us through our everyday contacts with them. Man has not changed, seems not to have evolved at all within the last two thousand years. All the advantage we have to-day over the men of ancient times lies in a greater wealth not of mental capacity but of factual and theoretical knowledge. We have, in fact, exaggerated the contrast between the totality of man's knowledge and his very limited capacity to absorb more than a part of it. How far can the contrast be carried without disaster?

In the past we have depended very largely for engineering advancement upon the works of individual men of genius and inspiration, Watt, Trevithick, Murdoch, Penn, Whitworth and Parsons, to name but a very few of them. But we fear that now in the middle of the twentieth century it is no longer possible, even within the narrow limits set by mechanical engineering, that a single mind can grasp all or nearly all that is necessary for the achievements of its purposes. Is it not significant that there is no name indisolubly connected with the development of radar to set beside that of Marconi in wireless telegraphy? Who was the inventor of the atom bomb? The name of Whittle is, it is true, peculiarly associated with the development of the aircraft gas turbine. But in the sense we use the term of Watt and Stephenson and Parsons, Whittle is not an inventor. Rather, his enthusiasm and boldness became the driving force behind a team of specialists developing to practicality an otherwise well-known device. For to-day, it seems, the work of engineers has become a matter so complex that it far surpasses in many fields the limited capacity of any single intelligence. Research and development must now be carried out by teams each member of which has detailed firm knowledge only about his own particular field. Physicists, chemists, mineralogists, metallurgists, even botanists and zoologists and other scientists must be associated with engineers in carrying out investigations and making reports. Committees in the past were limited in function to management. Now it seems committees must do the actual research work! That is the practical solution that engineers and scientists have devised to meet the problem set by the limited capacity of the human mind. Is it we wonder an effective answer? In the past we relied for advances upon the peculiar qualities of men of genius. Can genius shine in committee? Can a committee stimulate genius? Can its composite mentality transcend that of the individual intelligences that comprise it? Upon the answers we feel able to make to such questions will depend our opinions about the future rate of advancement of engineering theory and practice.

Literature

The Newcomen Society Transactions. Vol. XXII. 1941–42. Published by the Society, 43, King's Road, London.

It is pleasant, indeed, after an interval of several years imposed by war restrictions, to see a volume of the "Transactions" of the Newcomen Society in its familiar form and type and of almost as good quality as ever. These "Transactions" have an air, becoming in the works of an antiquarian body, that distinguishes them from all others, and we trust that the English edition will continue to maintain its personality and not seek modernisations or endeavour to popularise itself by the arts of the publicity expert. When dealing with modern affairs it is fitting to be modern; but when concerned with the past, a certain antique dignity is becoming.

The present volume covers the session 1941–42 and includes many attractive papers besides another instalment of the Analytical Bibliography of the History of Engineering and Technology. We are pleased to see a note on the beginnings of the Society by one of its principal initiators and its first President, Mr. Arthur Titley, written on the attainment of its majority. This little page of history had never before been printed, and Mr. Titley has presented it charmingly. The only omission is a reference to the origin of the motto and crest of the Society. The motto was written offhand by the late Mr. E. Kitson-Clark at a committee meeting of the Institution of Mechanical Engineers! It was subsequently submitted to the scrutiny of two classical authorities and on their approval was adopted. It is well that a world devoted so much to the present and the future should be reminded that looking back on the great past may help us on our forward path. As one of the *philosophes* of the eighteenth century remarked, "He will never think of posterity who never thinks of his ancestors."

We note also another little paper that was much wanted. Many engineers are familiar with Stuart's delightful duodecimo volumes of "Anecdotes" of steam engines and engineers, but few know anything about the author, Robert Stuart Meikleham. Mr. H. W. Dickinson and Mr. A. A. Gomme are to be thanked for collecting the facts about his life and works. Mention must be made also of the Presidential Address by Colonel C. E. Davies, an American member, entitled "What's Past is Prologue." It was fittingly written to celebrate the majority of the Society. It throws some light on the development of the Society in America and upon the course it is taking there.

Another very welcome paper is entitled "The French Civil Engineers of the Eighteenth Century," and was contributed by Mr. S. B. Hamilton, M.Sc. We know all too little about French engineering, and Mr. Hamilton's paper, a mere sketch as it were, may tempt some to follow the matter into greater detail. He tells us that civil engineering as a profession had its birth in eighteenth century France and reminds us of Telford's interest in French technical literature and of his gift, when first President, to the Institution of Civil Engineers of his library, amongst which were many French works.

Fourteen papers are reprinted in this volume, and we cannot give the space even to name them all, but one more, because it opens a new field for the technical historian must be mentioned. It was written by Dr. Herbert Chatley, is entitled "The Development of Mechanisms in Ancient China," and was, very fittingly, read in the Royal Asiatic Society's rooms.

SHORT NOTICES

Workshop Calculations for Machine Tool Operators. By G. Williams, B.Sc. London: Sir Isaac Pitman and Sons, Ltd., Parker Street, W.C.2. Price 10s. 6d. net.—In this book the basic principles of machine tool operations, together with formulæ and methods of solving problems, have been set out in a clear, concise manner which any operator with a reasonable knowledge of mathematics will find easy to follow. A wide field of application has been covered and the book will be both instructive and of considerable practical use, not only to machine tool operators, but also to students and teachers.

Conveyors and Cranes. By W. H. Atherton, M.Sc. London: Sir Isaac Pitman and Sons, Ltd., Parker Street, W.C.2. Price 25s. net.—This book is divided into three main sections. The first part deals with the mechanical handling of goods in package form; the second with the handling of loose materials; and the third with cranes of several types. Each type of mechanical appliance is dealt with in a clear concise way and the facts on the essential features of design are supplemented with data, tables and drawings where desirable. This book will be a useful guide to those contemplating the installation of a mechanical handling system, as well as to draughtsmen and designers concerned with the selection and application of conveyors and lifting appliances.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

L.M.S. DIESELS

Sir,—In your issue of May 9th, you published a letter from Mr. Brian Reed, in which he implies that although locomotive engineers are aware that the straight diesel locomotive has great advantages over the diesel-electric locomotive, they are doing nothing about it. As this is not the case, a reply is necessary on behalf of British locomotive designers.

Railway companies throughout the world were quick to take up the diesel-electric locomotive for two reasons: first, because of the obvious advantages of the power unit, and, secondly, because the straight electric locomotive was already proved in service, as was also the diesel-electric generating equipment. On the other hand, large mechanical transmissions for straight diesel locomotives could not be said to have been proved in service, and the designer and manufacturer have had, therefore, much greater difficulty in selling their products. Progress has therefore been slow, but great progress has, nevertheless, been made.

Horsepowers are on the increase and straight diesel locomotives of 500 h.p. with simple mechanical transmissions are at present on order in this country and will shortly be in service. Personally, I have no hesitation in saying that horsepowers will continue to increase and that the next ten or twenty years will show the straight diesel locomotive superseding the diesel-electric locomotive, even in the highest powers.

Leeds, May 29th. John Alcock.

The Future of the Electricity Supply Industry*

IN this abnormal year none of the usual topics appears to be wholly appropriate since on this occasion the subject of Nationalisation transcends all else and could hardly be other than the main theme of my address. So much has been said and written about the Electricity Bill that I cannot hope to do more than underline some aspects requiring earnest consideration in the coming period of change-over and reorganisation.

The Past

To understand the present, or to make any forecast of the future, it is essential to consider the past, even if somewhat briefly.

The electricity supply industry is perhaps the youngest of our major industries. Whereas in this country coal has been mined for centuries and railways have existed for well over 100 years, public supplies of electricity have been established for little more than fifty years. Within the memory and experience of engineers still in the industry it has developed from experiment to the great public service as we know it to-day. The number of consumers has grown from a mere handful to over 11,000,000, and the invested capital in the industry now exceeds £800,000,000. Supplies have spread into the vast majority of homes, commercial premises, workshops and factories. The applications of electricity have invaded all fields from lighting and other domestic uses to traction and every branch of industry, to medicine and surgery, radio and television. No better picture of the universal use of electricity, nor grimmer realisation of what modern life would be like without it, could be provided than by reminding you of the many hardships so recently experienced when public supplies were withdrawn or restricted. It has, in fact, become, after coal, the greatest single factor in the internal economy of the country.

Despite its overwhelming importance to the national wellbeing, it is not a big industry in terms of employment. Its 120,000 personnel compare with 700,000 in coal mining and 1,400,000 in railways and other forms of transport. It was one of the first, if not the first, of the major industries to adopt Whitleyism as a means of negotiation of wages and working conditions, and it is noteworthy that no major strike has ever occurred.

The existing authorised undertakers comprise 365 local authorities, 195 companies, and eight joint authorities. Their general powers are contained in a series of public general Acts, the consolidation or codification of which is very much overdue. Special mention may be made of the 1919 Act, which established the Electricity Commissioners, and the 1925 Act, under which the Central Electricity Board was created.

Committees set up by Parliament have investigated and reported upon the industry from time to time, the most recent of these being the McGowan Committee, which reported in 1936. This was followed by the Outline of Proposals issued by the Ministry of Transport in 1937, based on the Report and tentatively suggesting various groupings of existing undertakings. These two documents raised a storm of protest and caused much commotion in the industry, but owing to the impending threat of war, no further steps were then taken.

During the inter-war years between 1919 and 1939 the industry made phenomenal progress, the total annual output expanding practically ten-fold. Then came the recent war, which had the same uniting influence on the industry as on the nation generally. Total annual output during the war period expanded from about 21,000 million units in 1939 to over 32,000 million units in 1945.

In 1943-44 each section of the industry reported to the Minister its views in regard to reorganisation. A Joint Report which became known as the White Memorandum, contained a candid statement of the features admittedly requiring attention, and recommendations for effecting the desired improvement. The Association's own views of other aspects were submitted in a document known as the Brown Memorandum.

This very brief review of some fifty years of development brings us to the position obtaining when the war ended in 1945, which may be summarised by stating that, while recognising certain aspects in which improvements were desirable, nevertheless the industry, both company and local authority, could fairly claim :—

(*a*) A proud record of past achievement.
(*b*) An enterprising post-war programme.
(*c*) An adequate and contented personnel and
(*d*) The fullest confidence in its ability to meet all needs.

It was in this atmosphere that, in November, 1945, the Government's announcement of the intention to nationalise the industry was received.

By its very constitution and objectives, this Association has always stood four-square for public ownership. This principle is laid down time and again in our reports and proceedings. It was declared openly and firmly in the Association's Brown Memorandum of 1944.

Therefore, as a fundamental issue, the Association could not but welcome reorganisation on a basis of public ownership. The Association was concerned, however, and deeply concerned, as to the form that such reorganisation should take and as to the part which local authorities would be expected to play in it.

When it became clear that under the Government's proposals, local authorities were not to be entrusted with ownership, the utmost efforts were made to secure for them an administrative responsibility at local or district level. Though pursued diligently by memorandum and interview over a long period, these efforts have so far failed and, as members are now aware, it is anticipated that local authorities will have only a consultative role in the structure.

The Future

In considering the future many questions come rapidly to mind. What will be the position of the local authorities, the manufacturers, the contractors ? How will nationalisation affect our Association and many other kindred bodies ? How will engineers and other staff be affected, and what will be their prospects ? How long will reorganisation take, and how will the industry carry on until it is complete ? These and many other questions arise. Knowing the dangers of prophecy, I do not propose to attempt specific answers. Neither time nor space nor prudence would permit. Nevertheless, these matters are of such vital concern that they must be considered in a general way.

Nationalisation is a policy for which a good case can usually be made out in theory. It appears attractive—it is easy to visualise a co-ordinated policy, unified control, and integration with other industries. It is urged, with particular reference to this industry, that it will replace the present large number of undertakings by a smaller number of more rationally chosen units, the present multiplicity of tariffs by a more uniform code, the present divergence of voltages and systems by agreed standards. It is urged also that the working conditions, welfare and training of personnel can be improved, that research can be co-ordinated and extended, that large scale operations will bring economies in various ways and permit of wider distribution and better service. These are the ideals; the problem is to find a practical solution approaching as nearly as possible to them.

First of all, let us agree that nationalisation will not of itself work miracles. It can do no more than provide the framework and the necessary facilities, but real success depends on human factors, the most vital of which are good management, the right spirit within the industry and public goodwill. In all industries, large or small, whatever the type of organisation, success ultimately depends on the man on the job—that is why it is so necessary to have the right spirit in the industry. Further, the ultimate test of all these schemes is their effect on the ordinary consumer—that is why it is so necessary to retain public goodwill.

Accepting these factors as fundamental to the success we all desire, each of them may be examined a little further.

The New Structure

The main structure of the proposed organisation comprises the Minister, with considerable powers of direction and regulation, a central authority with financial powers and general responsibility, and area boards with rather limited autonomy and responsible in the main to the central authority. In brief, a chain of newly created public boards responsible to the Minister and through him to Parliament.

The public board is a device to secure public responsibility without incurring the risks and complications of direct state trading. Various types already exist. The main difficulty with all such bodies is to combine public responsibility with commercial enterprise, two functions which to some extent do not blend at all well. It is not easy to find the right form of organisation, but fortunately within our own industry useful experience is available. First, local authority trading undertakings have already, and in a large degree, overcome these somewhat conflicting interests. Secondly, part of the industry has operated successfully under a public board in the form of the Central Electricity Board.

Public boards fall into two general types comprising either (1) functional members, each having whole time executive responsibility for specific sections of the work, or (2) one or two whole-time members and a number of part-time members. The latter type seems more suitable for the electricity supply industry and more likely to be responsive to public opinion, to view problems dispassionately and, having decided upon policy to leave the application to executive staff who are free from sectional pressure of any kind. The intention seems to be to have bodies of this type, a choice which it is felt will be endorsed by the industry.

From the Bill it is clear that the powers retained by Parliament, through the Minister, are extensive and, if rigidly applied, could embarrass the free operations of the boards. Here it is possible to draw on our experience of the Central Electricity Board. While in fact responsible to the Minister, successive holders of that office have interfered little, if at all, with the general policy of the Board. It is to be hoped, therefore, that in his relations with the new boards, the Minister will seldom find it necessary to use his formal powers. The assurances to this effect, which have already been given, are welcomed. Next, the dependence of the central authority on the Treasury is to be noted. While recognising that a Treasury guarantee cannot be had without the inevitable strings, here again it is hoped that general control will suffice, especially in view of the fact that, of all the industries which it is proposed to nationalise, the electrical industry is the most prosperous and involves the least financial risk to the Government.

The Bill further provides the central authority with rather tight control of the area boards.

* Abstracts from the Presidential Address, by J. S. Pickles, J.P., B.Sc., M.I.E.E.,; I.M.E.A. Convention, Bournemouth, June 20th to 27th.

Because the central authority is charged with the ultimate responsibility, this control is no doubt unavoidable, but it is hoped that area boards will be given the maximum amount of freedom of operation within a given policy. The area boards, subject to the general control of the central authority and the Minister, are left to reorganise the distribution side of the industry on lines to be determined by them, no indication being given in the Bill of the proposed arrangements below area level.

The area boards appear likely to be made up of a full-time chairman and possibly a full-time deputy chairman, the remaining members being part-time and presumably free from executive responsibilities, though each will no doubt take special interest in that side of the work where his particular experience lies. It is almost superfluous to say that the selection of the right men is of supreme importance.

The Area Consultative Councils are rather large bodies of twenty to thirty members, the success of which is viewed by some in the industry with doubt. Some channel by which the public can influence policy is vital, but there is at least a possibility that duplication or confusion with area boards' functions may creep in, and it would not be at all surprising if practice soon showed some alteration to be necessary in the composition or functions of these bodies.

In brief, the general impression of the new structure given by the Bill is of a rather tightly geared machine in which it seems imperative that flexible couplings should be introduced to ensure smooth running. This flexibility can and will be provided if full advantage is taken of the knowledge and experience available in the industry. In this connection the appointment to the Organising Committee of men of long and practical experience of the industry has given much satisfaction and reassurance.

The Change Over

When the Bill becomes an Act, what are the next steps that may be expected? Presumably the central authority and the area boards will be appointed without much delay, but they will require time in which to establish headquarters, to gather staff together, and generally put themselves in a position to control the industry effectively. Then the Minister will declare a vesting date on which existing authorised undertakers, whether company or municipal, will cease to exist. It is, however, inconceivable that any kaleidoscopic change can take place overnight in the daily routine of the industry. Continuity must be preserved and it is not unlikely that, with suitable control by the boards, existing organisations will be required to carry on as semi-independent units pending gradual, and to some extent evolutionary, formation of new district units by amalgamation. Such a process may well extend over a long period and it may be some years before the ultimate pattern is fully complete. During this transition period it is possible that local authorities as such, but no longer as electricity undertakers, may be required to act as agents of the boards for those functions in which it is impracticable to make a clear cut break immediately.

On the generation side, presumably the central authority will set up a technical body within the authority, not perhaps differing materially from the present technical organisation of the Central Electricity Board except in so far as may be necessary for power station staffs and relative management personnel to be taken over. The Bill appears to contemplate the ultimate separation of responsibility for generation and main transmission from that of distribution. Opinion varies as to the necessity or wisdom of this separation, it being argued by some that it would be more efficient for generating stations to be operated by the area boards, provision for which is also made in the Bill. An obvious possibility, however, is that the generation organisation may be based on the same areas as those of the area boards, possibly in the same headquarters, thus facilitating co-operation.

On the distribution side, it appears probable that the area boards will establish an executive staff at area level and will then decentralise by the formation of self-contained district units responsible for the day to day operation and routine in much the same way as the larger of the existing undertakings work to-day. Areas previously served by companies may in this respect be more readily dealt with than those of local authorities where the separation of closely knit staff, particularly on the commercial and legal side, and of joint arrangements of various kinds may well take time. The present higher executive staff will ultimately find their responsibilities enlarged in some aspects and restricted in others. At lower levels the staff will not feel the change so early and perhaps not to the same degree.

Some general standardisation of technical practice should be possible fairly quickly. Similarly, broad uniformity of general policy will be practicable within a comparatively short time, but elimination of many existing detailed variations may take an appreciable time.

While all this is proceeding, the industry cannot stand still or even pause. New generating plant extensions must not be delayed, new grid lines will be needed, consumers must be given the necessary day to day service, wages and working conditions may require adjustment and settlement, and in innumerable other ways continuity must be maintained. Obviously, most existing organisations, either in their present or suitably modified form, will be required to carry on until the new boards complete their plans.

I cannot pass from this forecast without a brief word as to the future of our own Association. It is obvious that the Association cannot possibly continue under its present constitution. Further, it would appear that any reconstitution would have to embrace all local authorities, since those that hitherto have not had an electricity undertaking will in future have a vital interest in the nationalised industry. Whether such an Association would be justified, or whether it is more practicable for existing local authority Associations to cater for these interests, is a matter for early consideration by the local authorities themselves.

The Spirit of the Industry

No industry, no matter how well organised, can be wholly successful unless it possesses the right spirit. This is an intangible but powerful factor, without which many a venture has failed or fallen short of expectations. It cannot be too strongly emphasised that unless the spirit which has created this industry is carried forward into the new organisation, then the rather hackneyed words of unification, co-ordination, and integration will be meaningless.

Fortunately, it is not a case of creating a new spirit but of maintaining that which already exists. This industry has always been a happy one. Among workers this is proved by the fact that serious labour troubles are practically unknown. Among staff at all levels the utmost good fellowship prevails. There are few departures to other industries or importations from outside.

Some of the reasons for this satisfactory state of affairs are:—

(*a*) The intrinsic interest of a profession based on a natural science.

(*b*) The uninterrupted expansion and prosperity of the industry.

(*c*) The excellent technical press.

(*d*) The stimulus of competition and rivalry.

(*e*) The reward of initiative and enterprise.

Believing that these are some of the very human considerations on which the success of all commercial organisations depends, I feel that they deserve the serious attention of the new authorities.

Continental Engineering News

The Eupen Dam

A large dam is at present under construction in Eupen, Belgium. Work was originally started in 1936. The dam is being built for the Belgian Ministry of Public Works in order to provide a reservoir, and thus increase the drinking water supply of the City of Liége and regulate the flow of the Vesdre River. It is hoped also that the supply of water made available will attract new industries to the district served. The dam is situated in the beautiful scenery of the Hertogenwald, and is a gravity structure. Its height above the bed of the river is 214ft and it will be 1475ft long. In plan the dam will lie on a curve having a radius of 1220ft. The thicknesses at the base and top are to be 170ft and 26ft respectively. The total volume of concrete to be placed is about 520,000 cubic yards, of which 470,000 cubic yards (90 per cent) are already placed. Before the war 3600 tons of building materials were used every day. A special railway line and yard were constructed for the purposes of the contractor. Owing to the war, works were considerably delayed and the dam will not now be completed before the end of 1948. The Eupen dam will retain about 33 million cubic yards of water.

Bridge Over the Tagus

A bridge over the Tagus is to be built at Vila Franca-de-Xira, about 19 miles from Lisbon, Portugal. The design approved by the Portuguese Government is a suspension bridge with a central span 850ft long and two side spans 425ft long each. The decking will accommodate a 29ft 6in roadway and two footpaths each 5ft wide. The architectural treatment of the bridge will be similar to the bridge over the Rhine between Cologne and Mülheim, built in 1929.

Public Works in Spain

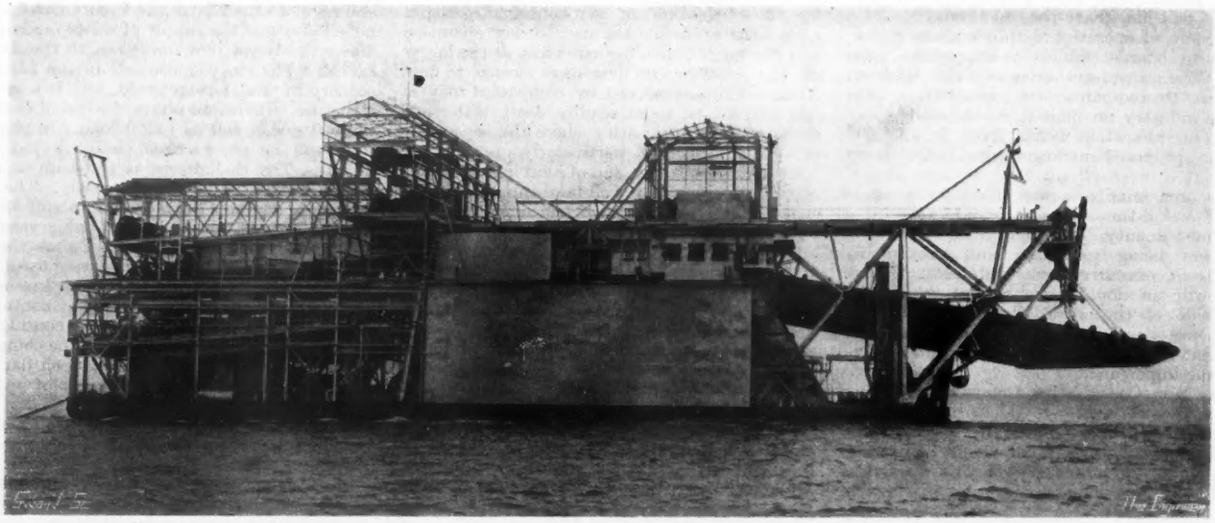
In an account recently published about public works carried out in Spain during the last ten years, Professor A. Pena Boeuf, former Minister of Public Works, refers to 1564 bridges built in that decade, including 89 long-span bridges. Amongst these structures are numbered the Esla viaduct, one of the four longest concrete arches in the world; a railway bridge of cellular construction with a span of 672ft and a rise of 192ft; the Tortosa bridge, a bow-string structure of the Langer type, with three spans of 180ft, 182ft 6in and 180ft; the Tordera bridge, an interesting example of composite steel and concrete construction, consisting of three spans of 148ft, 178ft and 148ft, each span carried by two fish-bellied trusses with concrete upper chord, while the lower chord and the diagonals are of electrically welded steel; the El Pedrido bridge, of the bow-string type; and the Amposta suspension bridge. Amongst hydro-electric works mentioned there are forty-three dams built or under construction. Since 1940, 400,000 acres of land have been irrigated. Other notable works mentioned include the Tardienta aqueduct, built of concrete, one of the largest aqueducts in Europe, with a discharge of 2500 cubic feet per second, and the new horse-race stadium in Madrid, comprising a reinforced concrete grandstand of an original design, due to Professor Ed. Torroja.

Swiss Railway Centenary

The first Swiss railway line, 14½ miles long, linking Zurich with Baden, was opened on August 7, 1847. This year therefore Swiss railways are celebrating their centenary.

The present length of Swiss railway lines is 3700 miles, of which 78·7 per cent are electrified. Of this figure, 1800 miles, i.e., nearly 50 per cent, are operated by the Swiss Federal Railways. The Federal Railways possess at present 546 electric locomotives, 333 steam locomotives, 159 mountain locomotives, 3426 passenger cars and 18,691 goods wagons. In addition, there is a small amount of rolling stock for narrow-track lines (47 miles). Besides the Federal Railways there are some private railway companies, such as Rhätische Bahn (narrow-gauge, 880 miles of lines); the Bern-Lötschberg-Simplon railway (normal gauge, 75 miles of lines); &c. Rivers and mountain ravines are spanned by 4939 bridges, of which 1291 have a length exceeding 33ft. The total length of Swiss railway bridges amounts to 250,000ft. There are many tunnels, 150 of which have a length of 1000ft and more.

TIN DREDGER FOR THE EAST INDIES



DREDGER "ROOSEVELT" RIGGED FOR TOWING

Large American - Built Tin Dredgers

TWO of the largest tin mining placer dredgers ever constructed in the United States have been designed by the Bucyrus-Erie Company, of South Milwaukee, Wis., to the order of the Mining Equipment Corporation, of New York, a subsidiary of the Billiton Company, of The Hague, Holland. These dredgers are to be operated in the East Indies, and we are indebted to the Bucyrus-Erie Company for the following details and the illustrations of the new equipment.

The special dredging machinery was built by the Bucyrus-Erie Company and the Tampa Shipbuilding Company, of Tampa, Florida, was selected as sub-contractor to prepare shipyard working drawings and build the hull, superstructure and housing. This company also assembled and installed the dredging machinery and equipment under the general guidance of the main contractors.

The first dredger was launched on October 28, 1946, and was named the "Stuyvesant." The second, the "Roosevelt," was launched on January 6, 1947, and the photograph we reproduce above shows the vessel at the outset of the voyage to the Dutch East Indies on May 9, 1947.

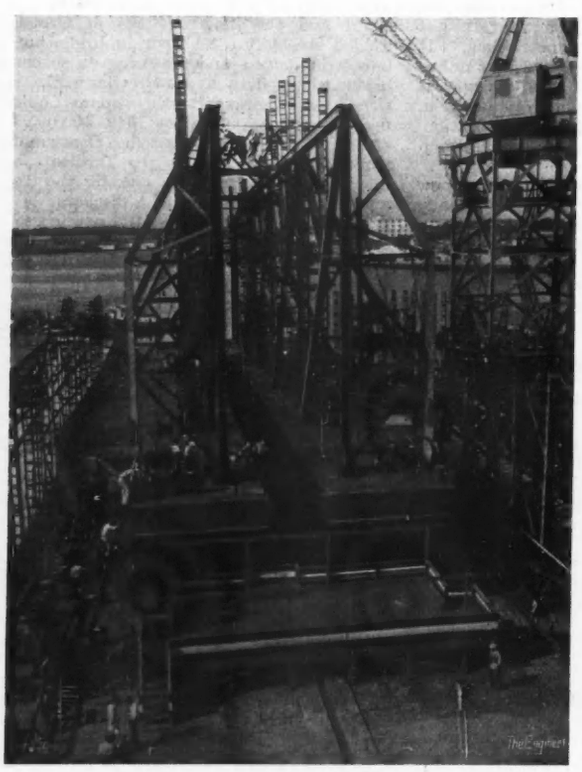
The two dredgers are identical in design and have been built to excavate tin-bearing sand and gravel to a maximum depth of 100ft below water level. Each hull is 246ft long, 76ft wide and 12ft 6in deep, the estimated working displacement being 4150 tons. The total length over the gangway bridge at the bow and the tailing sluices at the stern is 476ft. A pilot house is situated 36ft above deck level, whilst the highest point of the dredger is some 85ft above water level.

The fabricated steel hull is divided into fifty-two compartments by two longitudinal watertight bulkheads and twelve main transverse bulkheads, the ladder well and miscellaneous tank bulkheads. Four longitudinal trusses extend the full length of the hull, which has transverse frames spaced 2ft apart, except at the extreme stern, where longitudinal framing has been adopted. The hull is further strengthened by a pair of main trusses set 9ft off centre port and starboard. The upper chord of these trusses is 50ft above the main deck and has diagonal and lateral bracing. At the forward end of the hull is a well or slot 8ft wide and 140ft long to accommodate the digging ladder. This well extends the full depth of the hull and divides the vessel into two separate structures for more than half of its length.

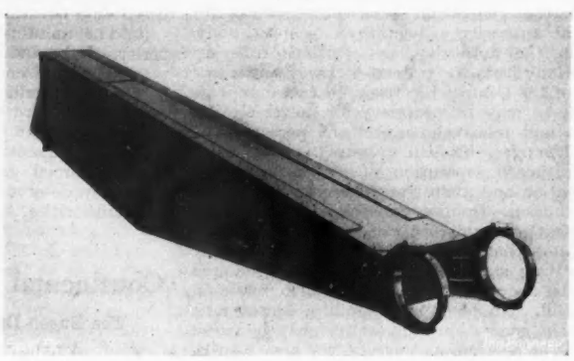
Digging Machinery and Working Plant

The digging ladder is 216ft long and weighs 220 tons without its equipment; with the buckets, rollers, idlers, tumblers, &c., it weighs some 650 tons. This ladder, which is 8ft wide and 13ft deep, carries an endless chain of 148 manganese steel buckets. Each bucket weighs, with its pin, 4025 lb and has a capacity of 14 cubic feet.

The upper or inboard end of the ladder is pivoted on a trunnion 57ft above the water line. Buckets are actuated by an upper tumbler, the driving machinery of which is powered by a d.c. motor with Ward-Leonard control. Idler rollers spaced along the ladder support the bucket chain. The ladder is suspended by two tackles from a heavy bow gantry extending 30ft beyond the forward end of the hull. This suspension tackle is operated by another d.c. motor, with similar control gear, geared to a quadruple drum winch situated on the top chord of the main truss. With this tackle the



PRE-LAUNCHING VIEW OF THE "STUYVESANT"



UPPER END SECTION OF THE 216 FT. DIGGING LADDER

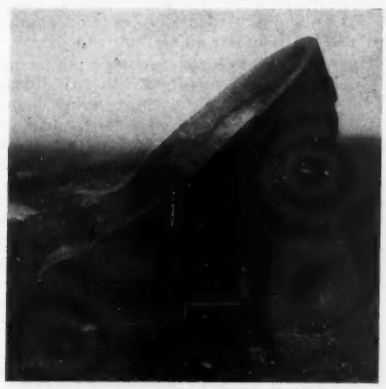
outer end of the ladder can be raised or lowered in an arc to dig material to the maximum depth of 100ft below water level.

Material raised by the buckets is discharged into a revolving screen, 10ft diameter, 70ft long and weighing 90 tons. Tin-bearing concentrates from the screen first pass over twenty-four four-cell primary jigs, after which additional jigs further refine the concentrate through second and third stages. The concentrates finally produced are then loaded on to barges for shipment to refineries. There are 128 cells in all in the jig washing plant.

Waste material or tailings are discharged 150ft astern of the dredger at a height of 6ft above water level, through chutes from the main jigs. When barren overburden is being dug a removable chute is placed in the revolving screen and the material passes along this chute to by-pass the treatment plant. From the chute the material passes into a central sluice, which discharges it 120ft astern.

At points where excessive wear is likely to occur the hoppers and chutes are lined with abrasion-resisting steel plates, and the distributor and disposal sluices are lined with a special rubber composition which is vulcanised to the plates.

Some 1½ million gallons of water an hour are required to wash and sluice the tin-bearing



14 CUB. FT. BUCKET

sands, and six 12in and one 5in pumps are installed to supply this water.

CONTROL AND POWER EQUIPMENT

Whilst it is working a dredger is manœuvred by means of six lines—two bow swing lines, one head line, two stern lines and one tail line. These lines are handled by six independent winches, each of which is driven by a d.c. motor with Ward-Leonard variable-voltage control. All of the equipment for the variety of dredging and other operations is controlled by electric and hydraulic means, and practically all of it is automatic. The lay-out of this equipment is such that the operator's principal job is restricted to handling the controls of the various motors with the minimum manual effort.

Power for the large number of motors on a dredger is supplied by three diesel engine driven generator sets, one of which serves as a standby. The diesel engines are of the vertical, four-cycle, trunk piston, solid-injection type, each having eight 13in by 16in cylinders. These engines are supercharged and each develops 875 h.p. at 375 r.p.m. Each engine is coupled to a 600-kW, three-phase, 50-cycle, 400-V generator. Whilst overburden is being dug one generating set is sufficient to supply the full power requirements of a dredger. Two 75-kW diesel generator sets are also installed for emergency standby and auxiliary service.

The safety equipment installed is particularly comprehensive and includes a bilge alarm system for each water-tight compartment, a freeboard alarm at each corner of the dredger, a depth indicator and a revolution counter. Other devices for indicating and recording the performance of all major units include a gauge panel on which is indicated the operating conditions of all units in the tin concentrating plant.

The preparation of the dredgers for their launching at Tampa and towing to the East Indies involved a fairly considerable amount of work and is of some interest. We reproduce a photograph which was taken prior to the launching of the "Stuyvesant,". The hull and main truss were substantially complete at the time, giving a launching weight of 1150 tons, including 135 tons of water ballast in the after compartments.

Heavy plate brackets were installed temporarily in the ladder well to tie the port and starboard sides of the hull together. Careful alignment of the hull and the launching ways was necessary owing to the breadth of the hull, which left a clearance of only 2ft on each side. After launching, the superstructure was built and the machinery installed at an outfitting pier.

In preparation for the voyage to Banka, the digging ladder was secured in position well above the water line, with all buckets removed and stowed aboard the dredger. The main deck houses enclosing the engine-room and machine shop were provided with water-tight doors and plate closures set over all windows and other openings. Plating which would offer undesirable surfaces to storm winds was removed from the sides and roof of the treatment house and from the upper houses enclosing the ladder hoist machinery. The pilot house was fitted with temporary galley and living quarters for the eight men forming the towing crew, and necessary safety equipment, such as lifeboats and rafts, was installed. Exposed motors, chutes, sluices and various items of the treatment plant were stowed and secured within the machine shop. Canvas covers were provided for exposed motors which could not be stowed. All cranes and hoists were securely chocked to prevent any motion, and a V-shaped bulwark, 10ft high, was built across the after end of the main deck, and heavy temporary shoring installed in the scow-shaped after compartments to resist the battering of heavy seas which might be encountered, as the dredger is being towed stern first, with the bow or ladder end trailing.

The towing bridle consists of a 2¼in stud link chain attached to a 2in cable leading to the towing winch on the tug. The tow is being made with approximately 1800ft to 3000ft of cable out, depending upon weather conditions.

The 13,000 miles towing operation involved in delivering the dredgers to the East Indies is the longest international tow to be made under the flag of the United States. For this purpose big diesel-engined ocean-going tugs built during the war have been chartered from the U.S. Maritime Commission. The trip is being made *vid* the Panama Canal and is estimated at three months with one stop at Pago Pago, in American Samoa, for refuelling.

Reconstruction of the Italian State Railways

RECENTLY we received from the Italian State Railways some particulars of the damage they sustained during the war and of the efforts to restore normal working since the end of the war. We reprint below extracts from the statement.

The recent conflict covered our whole country and engaged all the resources of the opposing forces. Therefore the ways of communication were the object of systematic destructive action by every means available. Indeed, as the war raged on the whole Italian peninsula, with incessant and massive air attacks and bitter land fighting, it caused terrific damage and devastation to the network of the Italian State Railways. Apart from this, there was methodical destruction by the German invaders as they retreated.

THE DAMAGE SUSTAINED

It is impossible to describe in this brief document the particular damage which took place, but the huge extent of the disaster to Italian transport can be gauged by the following broad details. At the end of hostilities, destroyed or damaged works were as under:—

4500 km of line tracks (21 per cent of pre-war total).

2600km of station tracks (35 per cent).

68km of masonry bridges (28 per cent).

35km of steel bridges (45 per cent).

64km of tunnels (7 per cent).

10,000 various buildings (36 per cent).

3850km of high tension electric lines (65 per cent).

8200km of overhead electric wires (69 per cent) and about 40 per cent of signalling installations.

In addition, the following rolling stock was either destroyed, heavily damaged or removed:—about 2300 steam locomotives (59 per cent); more than 1000 electric locomotives (78 per cent); 170 electric railcars and electric trains (80 per cent); 770 motor railcars (96 per cent); 9900 carriages, luggage vans and mail vans (81 per cent); about 100,000 freight wagons (73 per cent).

This great destruction of plant and material was accompanied by almost intolerable conditions for the employees. These people, who fully accomplished their duties in spite of dangers and discomfort, found themselves without houses and clothes, in a state of semi starvation, and severely shaken by the losses of both relatives and personal possessions. But, none the less, they knew that the reconstruction of the Nation was chiefly based on the reconstruction of the railways and that until this became possible there would be no prospect of a return to normal conditions of life. This realisation aroused their fullest energies, so that the task of reconstruction was conceived and undertaken with firm determination. In this way, in little more than a year, quick and definite successes have been achieved beyond all hopes and expectations.

WORK OF RECONSTRUCTION

It is true that the Allied Armed Forces, with all their wealth of mechanical equipment, helped the resumption of traffic on some lines, but in most cases their work was limited to provisional reconstruction to meet the essential military needs, and therefore useless for any permanent plan, and sometimes even harmful to long-term reconstruction.

Thus, the huge load of reconstruction weighed almost entirely on the exhausted resources of our country, which has received only scanty help in industrial products from some of the United Nations. Nevertheless, notwithstanding the difficult conditions of our industries, lacking as they do raw materials, fuel and electric power, the work which has already been carried out is imposing.

We adopted the following priorities for our work: top priority for the rehabilitation of plant, the re-establishment of main lines in the shortest possible time; the employment of the maximum amount of labour with the minimum use of materials; the widest possible use of remnants and scrap material. By this means we have already rehabilitated the following: 50 per cent of destroyed or damaged line tracks; 50 per cent of station tracks; 42 per cent of masonry bridges; 20 per cent of steel bridges; 33 per cent of tunnels; 54 per cent of buildings; 48 per cent of high tension lines; 55 per cent of overhead electric wires, and 20 per cent of signalling.

Concerning rolling stock, the following data are of interest: some new electric locomotives class "E 424" and new light carriages are already in service; 7140 new goods wagons have been built; 14,000 heavily damaged wagons have been reconstructed. As the result of new construction and repairs, the rolling stock in use has been improved in the following ranges: steam locomotives, from 2000 to 2250; electric locomotives from 740 to more than 1000; electric railcars and electric block trains from 65 to 105; motor railcars from 126 to 180; goods wagons from 67,000 to 87,000 (in the latter figures, however, are included foreign wagons still circulating on the Italian network).

Other significant indications of the range of reconstruction are the figures for passenger-kilometres and ton-kilometres. These figures show that during the current period we have reached a passenger traffic higher, and a goods traffic not much lower than those of pre-war periods. Even the speeds of trains, after a necessarily slow restart, are rapidly nearing pre-war rates.

The results which we have described are only those of the first stage. It is, however, hoped that during the year 1949 the reconstruction of tracks, stations and buildings will be completed, and that it will, in fact, be already very advanced at the end of 1948. We may add the estimate that during the year 1947 doubling of tracks on the lines Milan-Florence-Rome-Naples-Battipaglia, on the line Modane-Turin-Genoa-Rome and on the line Turin-Milan will be completed. If we are able to carry out in full our programme of rehabilitation and new construction, at the end of 1950 our rolling stock will be, in its most up-to-date forms, better than in 1940.

As a whole, if the necessary raw materials come in time from abroad, if the financial means are available, and if Italian industries are able to maintain production, the Italian State Railway system will have regained its pre-war efficiency before the beginning of the Holy Year 1950, and will be ready to serve the exceptional traffic for that occasion.

When reconstruction is finished, the railway system will show itself improved from all points of view. The laying of tracks is being improved wherever possible without excessive expenditure; new types of track and switches have been adopted; the steel and masonry bridges are being more strongly built; the four-aspect signalling system is being adopted; the automatic bloc system is being extended and automatic repetition of line signals in locomotives will be adopted. The network of electrified lines will be greatly extended, because the change-over programme which has already been resumed, includes amongst others, the following lines at present worked by steam: Turin-Venice; Bologna-Padua, Voghera-Piacenza, Ancona-Bari, Messina-Palermo, Messina-Siracusa.

Concerning rolling stock, we may mention the projected construction of electric trains each composed of seven units, and the lightening of carriage bodies and improvements in the structure and internal adjustments of carriages in order to achieve a greater comfort for passengers. Continuous brakes and lightened axles and roller bearings will be adopted on goods trains, too, in order to effect the speedy transport of early fruits and vegetables and other commodities.

Plural Starting of Electric Motors

MANY mechanical drives involve the continuous running of a number of electric motors for long periods during which the starters remain idle. This kind of duty is commonly encountered, for example, in paper mills, and in continuous chemical processes, as well as in ships, where many of the engine-room auxiliaries are normally required to be started up not more than once per voyage. If there are several motors in the engine-room, the use of individual starters makes heavy demands on the available deck space.

In an effort to solve the problem of starting a number of motors economically, making the best use of restricted space, the General Electric Company, Ltd., Magnet House, Kingsway, London, W.C.2, some years ago evolved a "plural starter" system. Plural starting is an arrangement whereby a single common starter performs the duties that normally require a separate starter for each of a large number of motors. Provided that the number of motors to be controlled is sufficient to warrant its use, this method of plural starting not only saves space but reduces the prime cost and installation charges incidental to the provision of a separate starter for each of a group of motors. Moreover, fewer spare parts are required and in marine applications the amount of switchgear called for under classification rules is reduced.

The number of motors controlled by the plural starter varies with the requirements of each installation. For example, the 10,000-ton M.V. "Somerset," of the Federal Steam Navigation Line, uses a single plural starter to start up eleven motors varying from 8 h.p. to 40 h.p., whereas in a new passenger vessel now under construction there will be two starter equipments covering a total of twenty-four motors, ranging from 15 h.p. to 155 h.p. Recent improvements have resulted in considerable simplification of the system and also in an extension of the range of motor sizes which can be controlled in this way. Plural control for ships' motors at 220V is now particularly economical for a range of machines from 15 h.p. to 150 h.p., but the equipment can be made in larger sizes from 100 h.p. to 350 h.p. for industrial installations. Although the system is primarily designed for starting d.c. motors, it can in many cases be employed with a.c. motors, unless they are arranged for star-delta starting.

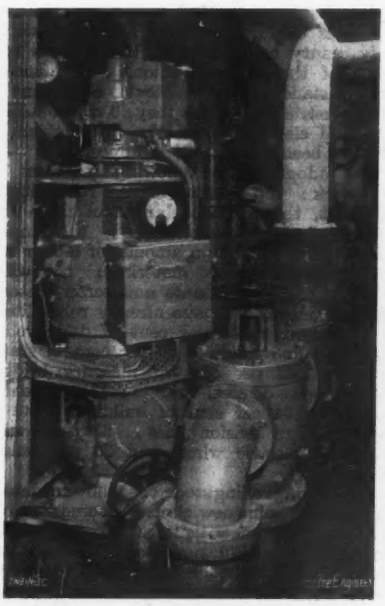
The following description is based on the plural starting installation in the engine-room of the M.V. "Somerset," which provides a typical example of the system in its improved form. The equipment comprises a motor control unit on each motor, an open type contactor panel for each motor and a common, or plural, starter for all the motors.

Each motor control unit is contained in a small steel case mounted directly on the motor in the place usually occupied by the terminal box, which is not required. Our first illustration shows the control unit fitted to 30/58 h.p. motor driving one of the ballast pumps in the M.V. "Somerset." The control unit contains the "start" and "stop" push buttons, indicating lamp and isolating links. Where required, a shunt regulator and an ammeter can also be mounted on the unit.

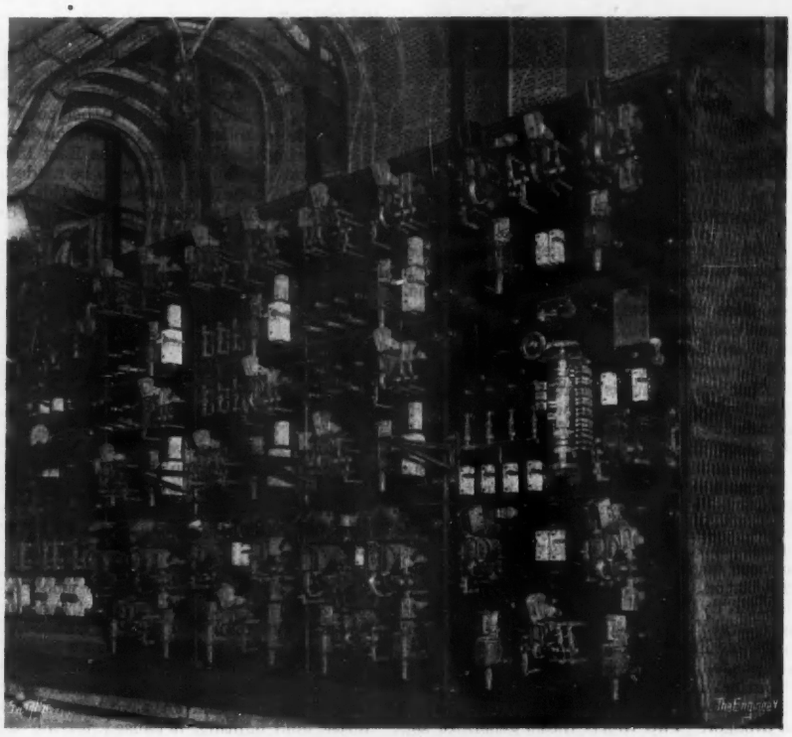
The rest of the plural starting equipment in this installation is embodied in a switchboard, which, as shown in the accompanying engraving, consists of eleven contactor panels (one for each motor) and a common or plural starter panel. Each contactor panel mounts line and starting contactors (one line contactor and one fuse for motors up to 20 h.p., a double-pole line contactor for machines over 20 h.p.), also a meter test link, an overload relay and a switch, or link, for isolating each individual panel, together with the associated motor and interconnecting cable.

In the switchboard illustrated herewith the plural starter is mounted in the central panel of the three right-hand panels.

The plural starter consists of the starting resistance and a motor-driven drum con-



CONTROL UNIT OF BALLAST PUMP MOTOR



PLURAL STARTER SWITCHBOARD

trolled by a pilot contactor. The drum has two driving motors, mounted at the back of the board, with a selector clutch so that either motor can be used. Alternatively, two complete common starters can be supplied, with a selector switch, one starter being a standby. The simplified arrangement of one drum and one resistance has been approved by the Classification Societies. The drum motor has two field windings, one connected across the armature and the other across the main starting resistance. When a small motor or a motor starting against light torque is started up, the voltage drop across the resistance is small. Thus the field of this separately excited winding is weak and the drum motor runs at, or near, its maximum speed. When, however, the motor being started is large or is to be started against a heavy torque, there is a considerable voltage drop across the resistance, resulting in a strengthening of the separately excited field, so that the drum motor runs at reduced speed, and the machine is accordingly started up more slowly.

Interlocks are provided to prevent the starter being connected to more than one motor at a time, and an overload relay for each motor gives full protection during both starting and running. For marine installations provision is also made on each panel for tripping from a "non-essential" tripping circuit, when this facility is desired.

Operation of the starter is initiated by pressing the "start" button, whereupon the starting and negative line contactors close and auxiliary contacts on these contactors start up the drum motor by means of the pilot contactor. As the drum revolves, the resistance steps are cut out until the drum has made one revolution, by which time the motor driven auxiliary is up to speed. The positive line contactor closes and the starting contactor opens, so that the motor is connected direct to line and the common starter is disconnected and is ready to start up another motor. When large motors have to be started the drum type starter is augmented by contactors or replaced by contactor starter operating under time control. Operation is similar to that of the drum type starter, the positive line contactor closing after the action of the last starting contactor.

In addition to those applications already mentioned, many others will suggest themselves. In particular, a promising field is provided by those industrial processes where a number of motors must be started in a predetermined sequence, such as in conveyor and material-handling installations.

Infra-red Heating by Gas

THE Infra Red Heating by Gas Exhibition, organised by the British Gas Council at Gas Industry House, 1, Grosvenor Place, Hyde Park Corner, London, S.W.1, which was officially opened on Thursday, June 19th, will remain open until the end of July. At the opening ceremony Mr. William Leonard, Joint Parliamentary Secretary of the Ministry of Supply, who was introduced by Colonel H. C. Smith, the Chairman of the British Gas Council, said that this new use of radiant heat was of tremendous importance to industry, since it saved time and coal, and widened many industrial bottlenecks. Thus drying metal finish on bedstead frames now took 8 min. instead of 600 min. previously. Agricultural machinery, which was so badly needed, took 6 min. to dry, whereas previously it required an hour. Other important applications of radiant heat were the drying of ceramics and the working of plastics. The British gas industry deserved, he said, the greatest credit for this new development.

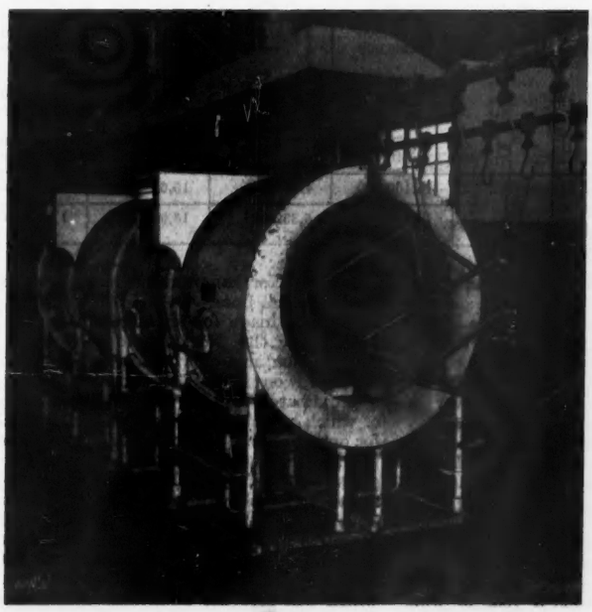
The exhibits show various articles dried and treated by radiant heating methods, and for those who cannot visit the exhibition information can be supplied at industrial gas centres throughout the country.

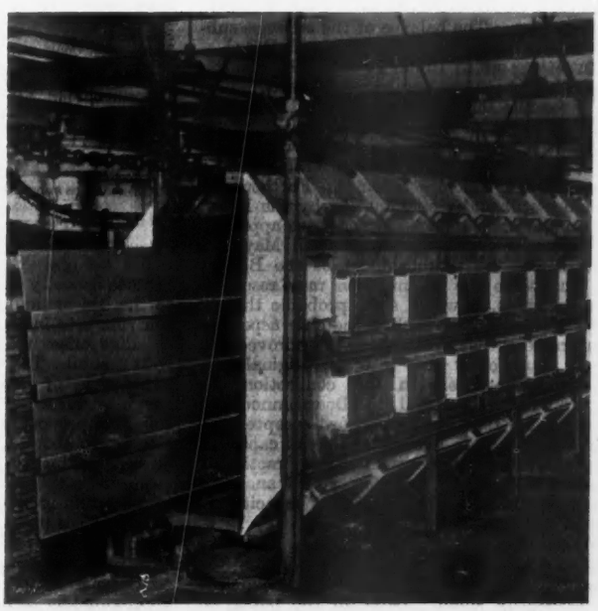
The accompanying engravings illustrate the two principal types of dryers, the black emitter tunnel and the flat panel type of dryer, both of which are on view, with the travelling conveyor for transporting the components. Examples are also displayed of the high-temperature incandescent type of dryer. The preparatory and development work on the black emitter burners was carried out in the research department of the Gas Light and Coke Company, and it has now been applied to a variety of industrial processes and is manufactured by different firms. In principle, dull metal plates are heated by gas burners and the plates radiate heat. The medium temperature range is from 450 deg. to 650 deg. Fah., but higher maximum temperatures, up to, say, 900 deg. Fah., can be attained. The high temperature range is from 1100 deg. to 1800 deg. Fah., but for almost all normal drying and, in particular, metal finishing processes, temperatures up to 650 deg. Fah. are adequate.

In the left-hand view we show an infra-red tunnel made by Neil and Spencer, Ltd., which is drying cycle frames at the works of Sterling Electric Holdings, Ltd., Dagenham. In this design of plant there is a row of gas burners, firing into a chamber bounded on the outside by insulation and on the inner side by a black panel of mild steel. An inner sheet or baffle plate is attached to the lower half of the radiating panel in order to protect the panel and to provide even heat distribution. The units are generally constructed in semi-cylindrical sections, 3ft and 4ft long, and of diameters 2ft, 3ft and 4ft, which may be joined together to form any desired tunnel length. A conveyor travels through the tunnel for transporting the components to be dried. The hoods above the tunnel for removing the burnt gas products may be noted.

Another pattern of heater is that with flat panels, which we illustrate in the right-hand view reproduced below. It was made by Thomas Potterton (Heating Engineers), Ltd., and is shown drying steel house components at the works of Steel Fabricators, Ltd., of Cardiff. The panels are arranged horizontally or vertically, and may be inclined to suit differing shapes of components. The same principle is adopted as in the previous design and the hot gases from the burner flow between a black radiating panel and an insulated back.

At the exhibition provision is made to demonstrate both these types of radiant heaters.





INFRA-RED PAINT DRYING TUNNELS

UNITED KINGDOM REGISTERED SHIPS.—The Minister of Transport wishes to draw the attention of all owners, managers and masters of, and other persons interested in, British ships to the fact that the Control of Trade by Sea (No. 2) Order, 1939, made under Regulation 46 of the Defence (General) Regulations, 1939, applies to all British ships, except fishing boats and Government ships, registered in the United Kingdom, the Channel Islands or the Isle of Man, and having a gross tonnage of 100 tons or more. It is pointed out that the procedure under the Order must be complied with, irrespective of the nature of the voyage contemplated and whether cargo is carried or not. The Order provides that no ship of 100 tons gross or over shall proceed to sea from any port on any overseas voyage except under authority of a licence granted by the Minister or by the Ship Licensing Committee (Overseas Voyages). Applications for licences for overseas voyages should be made to the Secretary, Ship Licensing Committee (Overseas Voyages), Ministry of Transport, Berkeley Square House, London, W.1.

The Iron and Steel Development Plan — Some Statistical Considerations*

By R. M. SHONE

No. II—(*Continued from page 541, June 20th*)

Progress of the Development Plan

The original Plan envisaged a total expenditure of £168 million at 1945 prices. The schemes involved were to be started over a five-year period and completed in seven and a half years. So far schemes totalling £140 million have been worked out in detail by the industry and have been submitted to the Board for final approval. Approval in detail has been given to schemes totalling approximately £90 million, and on these it has been possible to make a start and they are in varying stages of progress at the present time. Certain further schemes have been generally approved by the Board, but there are still problems connected, for example, with housing, &c., which are preventing a definite start being made. With these the total passed by the Board amounts to approximately £125 million. The balance of the schemes submitted are under consideration by the Board.

In setting out in Tables IV to VI the position regarding the Development Plan, the figures both for the schemes approved and for those at present under consideration by the Board have been grouped together to show the progress made in translating the general Plan into detailed and concrete schemes. Further, the schemes still under examination by the Board are in the main schemes which were approved in principle by the Government in May last year before the establishment of the Board; so that while the examination may result in some changes, it would seem probable that in their general lines, which is the only aspect of concern here, they are likely to be approved and to fit at an early date into the original construction schedule. In this connection the Chairman of the Iron and Steel Board announced on April 28, 1947, that the Board accepted the aim of the Plan in relation to overall capacity, considered that it represented the practicable maximum over the next few years, and also accepted the broad distribution of capacity set out in the Plan.

Since most of the major schemes will take approximately three years to complete, the amount of new construction already completed is necessarily small. Later in the paper an indication will be given of the extent to which the building at present going on will result in new capacity coming into use at an early date.

In estimating the extent to which the Plan has been submitted in detailed form for execution, the figure of the total expenditure on the schemes submitted of £140 million in relation to the original estimated cost of the Plan as a whole of £168 million tends rather to overstate the position. This would indicate that about 80 per cent of the Plan has been put forward. Tables IV, V and VI, however, which relate to the progress in physical terms, show that about 58 per cent of the blast-furnace building, 80 per cent of the steel furnaces and 66 per cent of the rolling mill developments, taken as a whole, have been submitted to the Board. Thus, about two-thirds of the capacity to be built under the Plan has been put forward in definite schemes.

While the total new building submitted represents about two-thirds of the total building under the Plan, the increase in capacity resulting from the plans already submitted amounts to 86 per cent of the total increase envisaged in the case of steel furnaces and 87 per cent in the case of blast-furnaces, as will be seen from Tables IV and V. The increase in capacity more closely corresponds to the ultimate increase because the more urgent schemes are in general aimed at expansion as well as increasing efficiency. Also, since the schemes are associated with a large scrapping of existing plant, much of which has still a useful life of a number of years, it will be possible, given flexibility in raw material supplies, to retain for a period some of this plant to achieve a high level of production pending the full completion of the Plan. Even when it is complete, if a capacity of 16 million tons is inadequate, there would be the possibility of retaining for a time some part of the capacity of 4 million tons which it is ultimately proposed to scrap and so permit an element of elasticity—given a corresponding elasticity of raw material supplies—in meeting requirements if they diverge materially from estimated requirements.

Steel Furnaces.—Turning now to the position in more detail, Table IV shows that on the steel furnace side new building totalling 4,148,000 tons has been submitted for approval, as against the total in the original Plan of 5,835,000 tons.

In addition, arrangements have been made to convert approximately one-third of the steel furnace capacity at present using producer coal to the use of liquid fuel. This will in general contribute to increased output from the plants as some offset to the increased cost of firing with fuel oil. The main use of coal in the steel industry is, of course, in the form of coke for the blast-furnaces, but the changing over of this high proportion of steel furnace plant may save up to about 1,800,000 tons of coal a year, or approaching 10 per cent of the overall coal required in pig iron, steel furnaces and the primary rolling processes.

Among the main schemes already approved is the new steelworks at Margam, in South Wales, with steel furnaces designed to supply the new continuous strip mill, which will produce approximately 1 million tons a year of wide coiled strip as a basis for further continuous cold rolling into tinplate and sheet. Site preparation work has already started here and the first new blast-furnace in connection with this plant came into operation at the end of 1946.

The scheme for a new steelworks at Dorman-Longs on the North-East Coast has also been approved. This plant incorporates a universal beam mill to produce broad-flange beams, which will effect important economies in the weight of steel involved in structural work.

In Lincolnshire, extensions to the steel melting shop at Lysaghts have been approved, together with the scheme for the laying down of a modern continuous billet mill producing 450,000 tons of billets a year. Considerable progress has already been made, both on the steel furnace and blast-furnace side, in expanding production in preparation for the installation of the new mill. A new melting shop at the Appleby-Frodingham works has been approved and construction is well advanced so that it should come into operation by the end of 1947. The modernisation of the heavy section mills at these same works is also proceeding.

The rebuilding and enlarging of the Round Oak Works, based essentially on the scrap arising in the Birmingham area, has already been started.

A scheme is under consideration by the Board for the rebuilding and enlarging of the steelworks, associated with the Summers continuous strip mill for sheet production at Shotton.

The proposed expansion of steel furnace capacity in Northamptonshire has been approved in its general lines. In the original Plan provision was made for an increase in steel production in the Northamptonshire area, the essential features of which were that it should be based on home ores and would provide approximately 500,000 tons of billets per year, of which two-thirds would initially be available for outside sale. A detailed examination of the possibilities showed that the most rapid progress in reaching the objective would be by an extension on the site of the Corby Works. A scheme has therefore been worked out by Stewarts and Lloyds involving the expansion of production at Corby by rather over 700,000 tons of steel, mainly basic Bessemer quality, which will give the additional billets required for sale and also provide a basis for the expansion of tube production made particularly urgent by the growing export demands. A problem still to be finally resolved in connection with this scheme is the provision of additional houses for the labour expansion required.

The areas in which major schemes have still to be submitted are for the further rebuilding of steel plant in the North-East Coast area as a basis for continuous billet production, and the extension of blast-furnace and steel furnace capacity in Scotland. In both these cases schemes have not the same urgency as certain of the other districts. Production of billets on the North-East Coast is already carried out in specialised plant giving many of the benefits of large-scale production. In Scotland the

Table IV.—*Steel Ingot Capacity. New Schemes Already Submitted*
(Tons)

	Present capacity.	New building.	Future capacity.	Increase in capacity.
South Wales	3,000,000	850,000	3,250,000	250,000
North-East Coast	3,050,000	612,500	3,250,000	200,000
Scotland	2,000,000	235,000	2,115,000	115,000
North-West Coast	360,000	—	250,000	110,000
Sheffield	2,100,000	13,500	2,100,000	—
Lancashire, Flint, &c.	1,000,000	700,000	1,175,000	175,000
Staffordshire	700,000	250,000	650,000	50,000
Lincolnshire	1,350,000	745,000	1,620,000	270,000
Northants	540,000	742,000	1,282,000	742,000
Total schemes submitted by the industry	14,100,000	4,148,000	15,692,000	1,592,000
Total original plan	14,100,000	5,835,000	15,950,000	1,850,000

Table V.—*Blast-Furnace Capacity, Basic and Hematite.—New Schemes Already Submitted*
(Tons)

	Present capacity.	New building.	Future capacity.	Increase in capacity.
South Wales	1,200,000	600,000	1,600,000	400,000
North-East Coast	2,200,000	400,000	2,332,000	132,000
Scotland	650,000	225,000	700,000	50,000
North-West Coast	650,000	—	650,000	—
Sheffield	150,000	—	150,000	—
Lancashire, Flint, &c.	250,000	100,000	350,000	100,000
Staffordshire, &c.	400,000	—	400,000	—
Lincolnshire	1,200,000	600,000	1,400,000	200,000
Northants	620,000	950,000	1,280,000	660,000
Total schemes submitted by the industry	7,320,000	2,775,000	8,862,000	1,542,000
Total, original plan	7,320,000	4,750,000	9,100,000	1,780,000

* Royal Statistical Society, May. Abstract.

problem of replacement of a large proportion of obsolete plant does not arise, nor is it one of the areas, mainly those based on home ore, on which the main expansion of production was designed to take place.

Blast-Furnaces.—Table V shows that in the case of blast-furnaces the schemes submitted provide for 2,775,000 tons of new building, compared with 4,750,000 tons in the original Plan.

Schemes approved include the extensions in South Wales in connection with the new South Wales Steelworks, the building of enlarged new furnaces at Lysaghts in Lincolnshire and the addition of two new large blast-furnaces at the Appleby-Frodingham works of the United Steel Companies to replace smaller units. These will be added to the two large modern furnaces completed at Appleby in 1939 and well advanced. The new window section mill at Darlington is coming into full operation. The plans for a new rod mill at the Lancashire Steel Corporation have been submitted. Schemes have also been approved for developments in other finishing sections of the industry, for example, in tubes, tyres and wheels, wire and stainless steel.

Taken overall, the rolling mill schemes already submitted would enable most of the production target figures to be reached, as in almost all cases the new building proposed is considerably greater than the net increase in production envisaged. There is in most instances a substantial reserve of existing capacity, some of which can be retained pending the completion of the balance of the Plan.

Timing of Construction.—The timing of construction has generally followed the line of priorities suggested as desirable in the original Plan. Priority has been given to a number of urgent schemes for developing output at existing plants where quick benefits would result. Indeed, some of the early benefits from the Plan will be realised during this year from new blast-furnace capacity in South Wales, on the North-East Coast, in Lincolnshire and Scotland, from the steel furnace oil conversion programme and from new steel furnaces, particularly at the melting shop at the Appleby works in Lincolnshire.

Among the major schemes, first priority was indicated as desirable for the new South Wales steelworks and strip mill for the production of sheets and tinplate. The second major scheme which was indicated as particularly urgent was the new broad-flange beam mill on the North-East Coast, designed not only to give a highly efficient production of heavy structural material, but also to provide an important new type of product for the export trade. Of the new continuous billet mills which, it was considered, should be proceeded with urgently, the first was that at the Lysaght plant, and this has already been approved and constructional work on the early stages of the scheme begun.

The phasing of the building plans has been worked out in detail and proposals for dollar requirements have been submitted to the Treasury. These involve a total dollar expenditure of approximately £15 million. This total is higher than the original sum of £9 million estimated in 1945, owing to the higher prices of plant in America and to some readjustment made necessary by limitations of construction in this country. The total expenditure in dollars represents about 7½ per cent of the Plan. Many of the items would not be obtainable in this country, but in the main the expenditure is designed to accelerate the completion of the Plan. Broadly, the extra time required to complete the Plan if dollar imports were cut down to very minor proportions would be approximately four years. The loss of exports and the additional imports required if the construction period were lengthened in this way would far more than offset the dollar expenditure involved in avoiding this delay.

TABLE VI.—*Rolling Mill Capacity*
(Tons)

	Present capacity.	New building.		Future capacity (on basis of schemes submitted).
		Original plan.	Schemes already submitted.	
Billet mills	3,700,000	2,200,000	1,000,000	4,400
Plate mills	1,750,000	500,000	350,000	1,750
Joists, rail and heavy section mills...	2,500,000	650,000	600,000	2,500
Sheet and tinplate mills	2,400,000	1,100,000	1,100,000	2,700
Light section, bar, rod and strip mills	3,175,000	1,000,000	650,000	3,500

provide a four-furnace unit. A third furnace has been approved at Consett, on the North-East Coast, which will be additional to the first modern furnace completed in 1942 and the second furnace, which is expected to come into operation during the course of 1947. A third furnace is also being built at the Clyde Ironworks in Scotland, which will enlarge the two-furnace plant completed at the beginning of the war. Blast-furnace developments at Corby are associated with the new steelworks extensions.

The main schemes still to be submitted are those for the expansion of pig iron production in Scotland and for the building of blast-furnaces at the Shotton Works to replace and increase the supplies at present drawn from the Midland area. A major modernisation of the blast-furnaces on the North-East Coast was also envisaged in the original Plan. Approval has already been given to the scheme for modernising the ore unloading and handling facilities in this area. This is proceeding at the present time and the further plans for the replacement and rebuilding of blast-furnaces on the North-East Coast are expected to come forward shortly.

Rolling Mills.—Table VI shows the extent to which schemes have been put forward on the rolling mill side.

In the case of billet mills, two schemes for development on home ore fields, in Lincolnshire and Northamptonshire, have been approved. It was always envisaged that development of billet production should first take place on home ore sites.

A scheme for the building of a new four-high plate mill, together with the concentration of the production at the Consett Works on plates, has been submitted, but not yet approved, for immediate construction.

Proposals covering the main developments in the heavier section mills are well advanced. Modernisation at the Appleby-Frodingham works in Lincolnshire is proceeding. Modernisation of the mills at the Round Oak Company, Birmingham, on medium sections is already under way. The scheme for the broad-flange beam mill on the North-East Coast, which is much the most important scheme in connection with the modernisation of the production of heavy structural material, has also been approved.

In the case of sheet and tinplates, the developments already referred to both in South Wales and Shotton have been approved. In the lighter mills, schemes have been approved for a new bar and rod mill integrated with the continuous billet mill in Lincolnshire and for further strip production at Corby. A rod mill at the works of Richard Johnson and Nephew has been approved and construction is already

American Engineering News

Design of American Dams

A report on hydraulic engineering by the American Society of Civil Engineers states there have been no new principles in the design of masonry dams, but that there is new activity in the study, particularly as to uplift water pressure and ice pressure on masonry dams. Construction of earth dams has been curtailed by war conditions, so that there have been no recent important developments either in design or in methods of construction. However, good practice will continue to depend upon the treatment of soil as a structural material. Present-day design of earth dams includes much greater spillway capacity than has been customary in earlier years, in order to ensure stability of foundation and embankment, reasonable watertightness and safety from overtopping. The embankment has a core or interior section of low permeability, with or without a foundation cut-off of soil, concrete or steel piling. Outer layers or shells are of coarser materials for drainage of seepage, with slopes flat enough to keep stresses within shearing resistance and to provide adequate stability. Recent trends in design are extreme precaution against overtopping, more extensive preliminary investigation of site, and adequate provision for safe discharge of such seepage as may pass through the so-called impervious portion of the dam. Both the hydraulic fill and rolled fill methods of construction continue in use, but the latter is gaining favour, largely because of the continuing development of soil transportation machinery of larger capacity and higher speed. Experience has indicated the importance of protecting the upstream face from erosion by wave-action by means of paving underlaid by a layer of coarse material. This material is to prevent the receding waves from washing out the embankment under the paving, as has occurred in some cases. Recent practice indicates a liberal use of random stone riprap or revetment for drainage and protection from waves. For control of foundation seepage, puddle is generally preferred to concrete.

Metallurgical Coke

Although most of the blast-furnace coke in the mid-west section of the United States—including the Chicago and St. Louis districts—is made from eastern coals shipped in from distances of 550 to 600 miles, there is study of the use of Illinois coal for this purpose. That State has reserves of high-volatile bituminous coal estimated at 150 billion tons, and research indicates that much of the low-sulphur coal may be used to make metallurgical coal by blending with eastern coals. Of 12 to 15 million tons of coal shipped in to the Chicago area annually, 50 per cent to 75 per cent is high-volatile bituminous, much or all of which might be replaced by Illinois coals mined within distances of 100 miles to 300 miles. The savings in cost of transportation might be partly balanced by higher moisture content, higher ash and lower coking power. Thus the problem of using Illinois coals in the production of metallurgical coke is a matter of experimental research in which the economics of the process must be a governing factor. Other factors are: (1) the preparation of coal at the mines; (2) selection of coal blends and the proportions of high-volatile and low-volatile coals; (3) coke oven operation adapted to the selected blends; (4) use of the coke in blast-furnaces. For about three years, one large blast-furnace plant has used a blend with 60 per cent to 75 per cent of Illinois coal in its coking ovens. All this coke is made in by-product ovens and is all used in the blast-furnaces. A steel company is also experimenting with Illinois coal in its coke ovens. Such ovens are usually 14in to 20in wide, 12in high and 40ft long, and are heated to about 2000 deg. Fah. Coal blends for coking must not expand to such an extent as to damage the oven walls, and it is thought that the pressure should not exceed 2 lb per square inch. The time of coking ranges from sixteen to twenty-four hours. A sample analysis of the coke shows 1·1 per cent volatile matter, 91·3 per cent fixed carbon, 7·6 per cent ash, and 0·73 per cent sulphur. On the basis of research and experimentation, it is considered that Illinois coal will become a normal raw material in the production of blast-furnace coke in the mid-West area.

Industrial and Labour Notes

The Steel Situation

The Lord President of the Council, Mr. Herbert Morrison, held the seventh in the series of press conferences, dealing with Britain's economic situation, on Wednesday of last week. Apart from a comment that the unemployment figure for May—332,000—was the lowest since the war, the major parts of Mr. Morrison's statement dealt with coal and steel.

With regard to steel, Mr. Morrison said that here was a shortage which had been threatening to replace the shortage of coal as our most vexatious and crippling bottleneck. The Government had reached the conclusion that it would be justified in increasing the allotment of coal and coke to the iron and steel industry for the summer months. The object, Mr. Morrison explained, was to give the industry something like its full requirements in the summer months, although it could not be guaranteed that in all cases the coal would be available in precisely the right qualities at the right places. The justification for giving the iron and steel industry additional fuel supplies was self-evident, for the demand for steel continued to run at very high levels indeed, and a substantial amount of steel output had been lost because of the fuel crisis.

Steel output, Mr. Morrison continued, had been high in recent weeks, but only at the expense of a serious running-down of stocks of pig-iron and scrap. Even if the industry were now enabled to produce at something like its maximum output, the amount of steel available in the summer would inevitably continue to fall below demand, owing to supplies from abroad not yet being available to us in the quantities we needed. It was expected that the broad effect of the increased fuel supplies would be that in the summer months, after allowing for the effect of holidays, the industry would be able to produce at about the same rate as had been achieved over the whole of 1946, namely, at about 12,700,000 ingot tons. Also, it was hoped to give sufficient fuel supplies to the industry in the winter months to push steel production in the last quarter of the year up to an annual rate of well over 13,000,000 ingot tons.

Mr. Morrison added that the maximum home production of steel was still not enough to meet the absolutely unprecedented demands for reconstruction, for re-equipment, for the export drive, and so on, which were the aftermath of war. Home capacity was only about four-fifths of our present need, and imports went only a little way towards filling the gap. Total home capacity could be increased but slowly, and imports from abroad could not in present conditions grow quickly. That was why the shortage must continue, and why no steel user should be misled into expecting the fulfilment of his unsatisfied demands for some time to come.

British Overseas Trade

From figures published by the Board of Trade, at the end of last week, it may be seen that the value of exports of United Kingdom goods in the month of May reached a total of £89,706,313, the highest figure to be achieved this year. The volume of exports in May is estimated as being 104 per cent of the 1938 average. The value of imports, which has been rising sharply since the beginning of the year, totalled £153,215,160 in May, and re-exports of imported merchandise amounted to a value of £7,061,375.

Analysing the month's export figures, the *Board of Trade Journal* says that the number of new motor cars exported in May, 10,670, was the highest on record, and was nearly three times the average monthly export in 1938. Exports of commercial vehicles, 4186, also recovered but were one-fifth below the average of the last quarter of 1946. Shipments of locomotives, however, were the lowest for nearly a year. Machinery exports generally declined during May, although machine tool exports reached a record figure of 4848 tons, or nearly two and a half times the monthly average of 1938. The reduction in the machinery group was greatest in agricultural implements the exports of which were the lowest for a year. There was an increase in exports of iron and steel and manufactures thereof, the May total being just over 164,100 tons, compared with 147,700 tons in April. The May figure just exceeded the 1938 monthly average.

Railway Wages

The Court of Inquiry appointed by the Minister of Labour to consider the railway trade unions' claims for increased wages and for a reduction in working hours has recently been meeting in public and, subsequently, in private session. Mr. C. W. Guillebaud, lecturer in economics in the University of Cambridge, presided over the Court.

The case for the unions was presented by representatives of the National Union of Railwaymen, the Associated Society of Locomotive Engineers and Firemen, the Railway Clerks' Association, and the unions allied to the Railway Shopmen's National Council. The claims included an all-round increase in wages of £1 a week, payment of double time from 4 p.m. on Saturday to midnight on Sunday, and a five-day week of forty-hours with a thirty-five-hour week of five days for clerical and supervisory staffs. In the evidence submitted, it was stated by Mr. W. P. Allen, of the Associated Society of Locomotive Engineers and Firemen, that many men had left railway service because of dissatisfaction with rates of pay and general conditions. The number of hours worked had risen to a "terrific figure" since last November, and he considered that in view of the responsibility placed on them, the demands of the locomotive men were not unreasonable. He added that the condition of many locomotives in use at present was worse than had ever been known in railway history. Mr. Benstead, the general secretary of the N.U.R., also supporting the claims, contended in his evidence that many outside factories had amenities far in advance of the railway workshops and said that it had been difficult for the unions to keep peace in the railway industry.

When the railway companies' evidence was presented to the Court, it was stated by Mr. H. Adams Clarke, on behalf of the four main line railways, that to give full effect to the claims, on a basis of a thirty-five-hour week for the salaried staff and a forty-hour-week for other staffs, would add about £90,000,000 to the wages bill, while a forty-four hour week would add about £60,000,000. The salaries and wages bill of the four companies in 1946 was £198,852,000. To meet the claims, Mr. Adams Clarke asserted, would mean a possible increase of passenger fares of 65 per cent and of freight charges of 70 per cent compared with the pre-war rates. He also said that any reduction of hours in the workshops, unless the companies could correspondingly increase output, would have a serious effect on the repair and construction of rolling stock which would adversely affect traffic. Sir William Wood, president of the L.M.S. executive, said he estimated that, for the whole of the current year, the net revenue earned by the railways would be £21,800,000 less than in 1946.

Coal Output

The Ministry of Fuel and Power announced on Tuesday last that, in the five weeks of May, the saleable output of mined coal in Great Britain averaged 3,581,400 tons a week and of opencast coal, 212,800 tons. The average weekly output during the four weeks of May in which a five-day week was worked was 3,516,800 tons of deep-mined coal and 198,900 tons of opencast. In May, 1946, the average weekly output was 3,702,500 tons of deep-mined and 217,500 tons of opencast coal. In the first two weeks of the present month the outputs of deep-mined coal were 3,660,600 tons and 3,691,200 tons, respectively, and on June 7th there were 716,600 wage-earners on colliery books.

The output per manshift worked at the coal-face averaged 2·86 tons for the whole of May and 2·88 tons in the period in which the five-day week was operating. Voluntary absenteeism averaged 6·01 per cent over the whole month and 4·65 per cent in the five-day weeks. In May, 1946, voluntary absenteeism was 9·46 per cent. The total tonnage of mined coal lost in the four five-day weeks of May, however, averaged 305,100 tons a week, of which recognised holidays accounted for 247,500 tons, disputes 34,200 tons, and accidents, breakdowns and repairs to machinery 20,900 tons.

The total inland consumption of coal was 3,390,000 tons a week in May and the provisional figure for the week ended June 7th was 3,228,200 tons. In the comparable week of 1946, inland consumption was 3,326,300 tons. The distributed coal stocks on June 7th were, according to a provisional estimate, 8,443,600 tons.

The A.E.U. National Committee

The annual conference of the Amalgamated Engineering Union's National Committee took place at Hastings during last week. It opened with an address by the President of the A.E.U., Mr. Jack Tanner, who, in commenting on home industrial affairs, said that only since the fuel crisis had we seen a practical recognition of the importance of engineering. The T.U.C.'s considered recommendations to the Government in connection with the Economic Survey had insisted that "the engineering industry must be mobilised, tooled and operated to produce maximum requirements in the minimum time," and it was gratifying to note that authoritative speakers were increasingly adopting that theme.

Mr. Tanner then went on to express the view that the trade union outlook and trade union machinery needed adjusting to the changing industrial situation, and, in conclusion, had a word to say about consultation and participation in management. In nationalised industries, he remarked, workers must obtain such participation to the fullest possible extent, but he pointed out that at the end of the present Parliament, 80 per cent of industry would still be privately owned. In private industry, Mr. Tanner continued, the workers "could not afford to be associated with the less pleasant aspects of management, but must largely confine participation to questions of production." Joint Production Committees, he thought, provided the most suitable method in such circumstances, and must be universally established and developed into the most effective medium for the purpose. It was essential, in order to give them official status and responsibility and to link their activities with the central plan, that they should be suitably connected with the Planning Board of the Government through the Regional Boards for Industry.

Among the resolutions passed at the conference was one relating to new wage demands in the engineering industry. With regard to the general wage structure, the resolution urged a national minimum consolidated rate, an increase in the piecework minimum to 33⅓ per cent, and a bonus agreement which would relate all time workers' earnings to piecework earnings. Furthermore, it recommended the conversion of some categories of workers at present designated as semi-skilled into the skilled grades.

French Engineering News

(From our French Correspondent)

PARIS, June 20th.

Monsieur Robert Cayrol, President of the "Carburant Modernisation Commission," envisages an increase of petrol imports from Iraq from one to three million tons by 1948. Consumption, which was about 6,500,000 tons in 1938, is expected to reach 11 million tons in 1950 and over 15 million tons in 1955. French policy is therefore concerned with production in Iraq and throughout the Middle East and with research, reconstruction of tankers and refineries, research on the chemistry of petrol and fuel oil alternatives, and the standardisation of transport and distribution methods so as to obtain the lowest prices possible. In France, North Africa and other French Union territory research is to be urgently undertaken. The pre-war tanker fleet carried about 40 per cent of total French imports. In future, French petrol tankers will carry at least 50 per cent of the imports, with emphasis on tankers of 16,500 and 21,500 tons, and later even higher tonnage. Refining capacity will also be increased. In 1938, out of 6,600,000 tons consumed, about 5½ million tons came from French refineries. Despite considerable destruction, capacity is expected to reach 5 million tons by the end of this year. Modernisation, to be undertaken in two stages, will increase refining capacity to 10 million tons in 1950 and 15 million tons in 1955.

* * *

Electrical construction work is still active and satisfactory. The Société pour le Travail Electrique des Metaux (T.E.M.) reports a turnover in 1946 twice that of 1945, which is only partly accounted for by higher prices. To meet current requirements, both in France and abroad, the society has begun modernisation and re-equipment of its plants and works and considerable expansion in production. The target is a 40 per cent increase in production capacity. The programme includes the construction of plant for making accumulators in cadmium-nickel, modernisation of the production of lead accumulators, and extension of shops for making transformers.

* * *

Strike movements and general dissatisfaction with hours and wages are hitting hard at the French effort at reconstruction of her industrial life. Strong efforts have and are being made by both sides to enlist public sympathy, and both the Government and the workers' leaders and committees are making statements to the Press, and billposting in public and at works and power and engineering plants, with a view to demonstrating their anxiety for nothing but a square deal. The Government is fighting fiercely to hold on to its freezing of wages, at any rate for a further six months. The labour side are promising to disturb the public as little as possible compatible with their pushing what they regard as their just claims. Skeleton maintenance staffs generally are keeping utility services and a certain amount of power and production going and servicing machinery and plant.

* * *

The Paris Fair closed at the end of May after having scored a record success. Although the total number of visitors has not yet been made known, it is known to exceed that of last year, when over 2,500,000 people visited the exhibition. At the traditional inventors' competition the first prize went to the inventor of a gear-changing mechanism for bicycles and the second prize was shared by inventors of an automatic machine for trimming hedges and of a bridge table for rapid distribution of the playing cards. A leading machine tool association manager told your correspondent that British exhibitors were quite satisfied with results from the point of view of French interest in British production, and inquiries were very plentiful. The difficulty was that the monetary situation prevented many firms from placing actual orders. There was much still to be done before British machinery and goods could be imported freely into France, he said.

Notes and Memoranda

Rail and Road

THE DARTFORD-PURFLEET TUNNEL.—The Minister of Transport stated in Parliament last week that tenders were about to be invited for the construction of the Dartford-Purfleet Tunnel. He was hoping that work on it would be started within the first two years of the ten-year transport plan but he could not give any definite undertaking.

A LONG LOAD.—A two-truck special train, carrying a long load consisting of two structural steel girders, each 102ft long and weighing 34 tons, was run by the G.W.R. and L.N.E.R., from Horsehay and Dawley to Hawarden Bridge recently. Owing to the unusual length of the girders and difficulties at curves, the G.W.R. kept the adjoining track between Horsehay and Wrexham clear of other traffic to ensure safe passage.

MOTOR VEHICLE PRODUCTION.—The monthly statistical review of the Society of Motor Manufacturers and Traders shows that in the month of April, 24,230 private motor-cars and taxicabs were produced in the United Kingdom, and 12,320 commercial vehicles, excluding battery electric vehicles. New registrations of motor vehicles in the month of March in Great Britain were 11,204 private motor-cars and 10,712 commercial vehicles.

A G.W.R. SHUNTING APPLIANCE.—An appliance resembling a small hand plough has just been introduced into this country from Belgium by the Great Western Railway and is to be used experimentally for shunting purposes in small goods yards where difficulty is experienced in providing locomotive power. It moves on a single wheel driven by a petrol-electric motor. The wheel is fitted with a rubber tyre with concave tread to enable it to run on a rail as well as on the ground. The machine, it is stated, will propel up to 150 tons, or approximately eight wagon loads.

Air and Water

CLYDE LAUNCHES.—During the month of May Clyde shipyards launched seven merchant ships, aggregating 20,450 tons, and H.M. submarine "Artful." In the first five months of this year thirty ships, aggregating 111,240 tons, have been launched on the Clyde.

MANPOWER IN THE ROYAL NAVY.—The Parliamentary Secretary to the Admiralty recently announced that the committee which is to examine the use of manpower in the Royal Navy has been constituted as follows:—Mr. J. T. Green, of Thos. Firth and John Brown, Ltd.; Mr. J. C. Little, Past-President of the A.E.U.; two senior naval officers; and one senior civil servant. His Honour T. Eastham, K.C., Senior Official Referee of the Supreme Court of Judicature, has consented to serve as Chairman of the Committee.

THE TRANS-TASMAN AIR SERVICE.—On April 30th the Trans-Tasman air service completed its seventh year of operation between Australia and New Zealand. Since 1940, a total of 33,000 passengers, 1,000,000 lb of mail and 50,000 lb of freight have been carried on 1900 flights across the Tasman, involving 2,500,000 miles flown. At first, one return flight was made each week, but this has been increased progressively and there are now seven flights a week each way. Until last year the service was maintained by two "Empire" class Short flying-boats, but the present fleet of Tasman Empire Airways, Ltd., consists of five aircraft, three 19-passenger "Empire" class flying-boats, and three 30-passenger "Tasman" class Short flying-boats. Another machine of this type is to be delivered this year.

STEVENAGE WATER SUPPLY.—The Minister of Town and Country Planning has received from D. Balfour and Sons, of Westminster, consulting engineers for the water supply at Stevenage, a report on the result of preliminary test pumpings, which shows that 3,000,000 gallons per day can easily be obtained. This, together with the existing supply, will provide for a consumption of 65 gallons per head per day for the new town's eventual population of 60,000. London's present consumption is 52 gallons per head per day. It is stated that the 3,000,000 gallons per day can be obtained from boreholes alone, without the costly wells and subterranean galleries, the necessity for which was at one time envisaged. The report suggests that many years are likely to elapse before the demand for water at Stevenage reaches this level, but other sources of supply are available when this becomes necessary.

Miscellanea

HANOVER TRADE FAIR.—An announcement issued by the Foreign Office (German Section) states that the first export Trade Fair for the display of goods produced in the joint U.S./U.K. Zones of occupation in Germany will be staged in the Vereinigte Leichtmetall Werke factory at Laatzen, approximately three miles from the centre of Hanover, from August 18th to September 7th, 1947. U. K. firms wishing to visit the fair should apply in writing to the Board of Trade, German Division, I. C. House, Millbank, S.W.1, giving details of products in which they are interested. Applications should be sent in as soon as possible.

TUNG OIL RESEARCH INSTITUTE.—According to *China Newsweek*, plans are being made for the establishment of a China Tung Oil Research Institute to improve the production and manufacture of tung oil, one of China's principal export commodities. The proposed Institute will be an independent organisation to be governed by a board of directors, with the Minister of Agriculture and Forestry and the Chairman of the Kwangsi Province serving as Hon. Chairman and Vice-Chairman of the board. The Institute will have its headquarters in Kweilin, Kwangsi, while branches will be set up in other tung oil producing provinces, such as Szechwan, Hunan, Hupeh and Chekiang.

THE ASSOCIATION OF CONSULTING ENGINEERS.—The annual luncheon of the Association of Consulting Engineers was held at the Waldorf Hotel, London, on Wednesday, June 18th, when Mr. G. Howard Humphreys, M.Inst.C.E., the Association's Chairman, presided over a large company of members and guests. The toast of "The Association of Consulting Engineers" was proposed by the Minister of Transport, the Right Hon. Alfred Barnes, M.P., who emphasised that there was no period in the history of the world when the experience and skill of the consulting engineer were more necessary than at present. The expansion that inevitably followed a time of war was expressed by a desire for improvements of all sorts, Mr. Barnes said, and the skill and capacity of the British engineer, which had proved so valuable during the war, would make a tremendous contribution to the work of reconstruction all over the world. After the Chairman had acknowledged the toast, Dr. J. F. Crowley proposed "The Guests," response to which was made by the Right Hon. J. A. Beasley, High Commissioner for Australia, and Mr. F. T. A. Ashton-Gwatkin, of the Foreign Office. The concluding toast was that of the "Chairman," which was proposed by Sir Cyril Kirkpatrick and was cordially supported by all present.

THE OLD CENTRALIANS DINNER.—The thirty-seventh dinner of the Old Centralians took place at the Drapers' Hall, London, E.C., on Monday evening, June 23rd. More than 180 Old Centralians and their guests were present and a very enjoyable evening was spent. The chair was taken by the President, Mr. F. H. Bramwell, F.C.G.I., and the principal guest was Sir Stafford Cripps, President of the Board of Trade. In proposing the toast of "The Old Centralians," Sir Stafford made a warm reference to the contribution made to the nation by the Finsbury Technical College and the City and Guilds Institute. Had there been a battle flag, he said, it would have carried such battle honours as "Mulberry," "Pluto," "Fido," and others. Since the closing of Cooper's Hill College, the City and Guilds Institute had done much to provide the technical and scientific skill required by the Indian railways and public services. He looked forward to further help being given, when the Government's India plan was consummated. He pleaded for a greater share for the engineer alongside his financial and administrative colleagues in furthering that national industrial development which was essential for our progress. The President, Mr. Bramwell, said that they welcomed Sir Stafford for his high office and his scientific and legal training, which helped him to appreciate the work of the engineer. When the housing problem had been solved, he hoped that it would be possible for a City and Guilds Hostel to be built for the students. It was, he thought, very necessary to increase our output of trained engineers and scientists, if we were to keep pace and lead in the competition between ourselves and the United States. The toast of "The Guests" was ably proposed by Sir Frederick Handley Page, F.C.G.I., in an amusing speech, and Sir Norman V. Kipping, Director-General of the Federation of British Industries replied. Tribute was justly paid to Mr. A. M. Holbein, the Secretary of the Old Centralians, for the excellent arrangements made.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Institute of Physics

Friday and Saturday, July 18th and 19th.—INDUSTRIAL RADIOLOGY GROUP: Electric Lamp Manufacturers' Association, 2, Savoy Hill, W.C.2. A Symposium on "Methods of Crack Detection."

Institution of Civil Engineers

Thursday and Friday, July 3rd and 4th.—NEWCASTLE-ON-TYNE ASSOCIATION: Summer meeting in Newcastle-on-Tyne.

Friday, July 4th.—BIRMINGHAM ASSOCIATION: Visit to Avonmouth Docks. 8.45 a.m.

Institution of Electrical Engineers

Saturday, July 26th.—N. MIDLAND STUDENTS: Summer Outing. 9 a.m.

Public Works Congress and Exhibition

Monday, July 21st, to Saturday, July 26th.—London, Olympia.

Royal Meteorological Society

Saturday, July 5th.—Summer meeting at Portsmouth.

Stephenson Locomotive Society

Saturday, June 28th.—Visits to Brighton works, Redhill and Brighton running sheds, Southern Railway.
Friday, July 4th.—Visit to Swindon Works, G.W.R.

Contracts

A CONTRACT has been placed with the British Thomson-Houston Company, Ltd., for the supply of the complete a.c. electrical equipment for five floating dredgers which will be used to cut a canal between Donjere and Mondragon, in the south of France. The supply to the dredgers will be at 13,500V, taken from overhead land-lines running parallel to the projected line of the canal, the low tension supply of 380V, 3 phase, 50 cycles being obtained from the secondary of a 1000-kVA transformer mounted on each dredger. The electrical equipment also includes high tension switchgear with protective equipment, low tension ironclad distribution switchboards, control gear, and a.c. induction motors, most of which are of the slipring induction type. The a.c. motors total 1080 h.p.; the bucket chain motor is of 350 h.p., and several motors ranging from 50 h.p. to 140 h.p. are required for the conveyer belt system used to convey the spoils to the shore. A sub-contract for the supply of motor control gear has been placed with Brookhirst Switchgear, Ltd.

Personal and Business

MR. NORMAN BILES, A.M.I.Mech.E., has been appointed publicity and advertising manager of C.A.V., Ltd.

MR. W. A. FAIRHURST has been appointed technical director of the Cement and Concrete Association.

MR. W. M. MCKENZIE has been appointed secretary and chief accountant of Bruce Peebles and Co., Ltd.

MR. S. F. STEWARD, of E. R. and F. Turner, Ltd., has been co-opted to the Council of the British Engineers' Association.

THE STOCKTON STEEL FOUNDRY COMPANY, LTD., announces that in future it will be known as Head Wrightson Steel Foundries, Ltd.

THE COLONIAL OFFICE announces that Mr. J. W. Duggan has been appointed assistant chief mechanical engineer in the Government Railway of Nigeria.

THE ROCKWELL MACHINE TOOL COMPANY, LTD., announces that its Midland area offices are now at 132, Steelhouse Lane, Birmingham, 4 (telephone, Central 3692).

MAJOR MALCOLM SCOTT SPEIR has retired from the position of Chief Officer for Scotland, London, Midland and Scottish Railway. He entered the service of the former Midland Railway in 1905.

THE GREAT WESTERN RAILWAY COMPANY announces the following appointments: Mr. A. N. Butland, assistant to chief engineer, Paddington; and Mr. P. H. Spence, assistant divisional engineer, Taunton.

A. C. WICKMAN, LTD., has been appointed sole selling agent for home and export (excepting Sweden) for the automatic hob and helical spline grinding machine manufactured by the Chatwood Safe and Engineering Company, Ltd.

MR. WALTER JOHNSON has retired from his position as secretary of Thos. W. Ward, Ltd., after fifty-nine years' service with the company. He is retaining his seat on the board. Mr. H. Beresford has been appointed to succeed him as secretary.

JAMES HOWDEN AND CO., LTD., announces the retirement from its board of Mr. J. B. McGillivray, who has been associated with the company for fifty-four years. Mr. J. S. Niven and Mr. H. L. Paul have been appointed directors.

THE BRITISH THOMSON-HOUSTON COMPANY, LTD. announces the following appointments: Mr. F. C. Barford, A.M.I.E.E., district manager, Newcastle-upon-Tyne, and Mr. J. Clement, M.I.E.E., district manager, Midlands area, at the Birmingham office.

DIAPLASTICS, LTD., radio heating equipment manufacturers, has been taken over recently by A. C. Wickman, Ltd. The board of the company has been reconstituted as follows: Hon. C. M. McLaren, chairman; Mr. A. H. Jarrard, Mr. G. C. Trowbridge, and Mr. E. A. Hyde.

SIR RONALD GARRETT has been re-elected chairman of Lloyd's Register of Shipping. Mr. Kenneth R. Pelly has been re-elected deputy-chairman and treasurer, and Mr. E. L. Jacobs, chairman of the sub-committees of classification. Sir George Higgins has been re-elected a member of the general committee.

THE MINISTER OF TRANSPORT has appointed Mr. P. E. Millbourn, chairman of Spencer (Melksham), Ltd., as Adviser on Shipping in Port. His functions will be to advise on and co-ordinate measures within the competency of the Minister of Transport to reduce the turn-round time of ships and connected problems in ports.

THE LONDON, MIDLAND AND SCOTTISH RAILWAY COMPANY announces the following appointments: Mr. J. Briggs, assistant chief engineer, Watford H.Q.; Mr. S. O. Cotton, engineer (structures), Watford H.Q.; Mr. H. B. Everard, engineer (permanent way), Watford H.Q.; Mr. R. L. McIlmoyle, assistant engineer (structures), Watford H.Q., and Mr. I. R. Frazer, engineer (Scotland), Glasgow.

THE BRITISH FOOD MACHINERY MANUFACTURERS' ASSOCIATION, of which Mr. Norman Neville is director, has been admitted to membership of the British Engineers' Association. Mr. Neville is also director of the British Chemical Plant Manufacturers' Association. The B.F.M.M.A. was formerly the Food Machinery Industrial and Export Group. Mr. E. H. Gilpin (Baker, Perkins, Ltd.) is Chairman of the new Association, and Dr. E. H. T. Hoblyn is secretary. The address of the Association is 26, Portland Place, London, W.1.

Reports on German and Japanese Industry

Limited numbers of copies of the reports of Intelligence Objectives Sub-Committees on German and Japanese Industry listed below can be obtained from H.M. Stationery Office at the prices stated.

No. of report.	Title.	Post free. s.	d.
B.I.O.S.:			
959	I.G. Farbenindustrie, Manufacture of Triphenylmethane Dyestuffs and Intermediates at Ludwigshafen and Hoechst	9	3
961	German Dyestuffs and Dyestuffs Intermediates: Azo and Lake Dyestuffs	15	3
967	Deutsche Vacuum Oel A.G., Hamburg, Germany: Fuels and Lubricants	14	4
972	German Small Nail and Tack Manufacture	2	2
988	German Dyestuffs and Dyestuffs Intermediates: Azoic Products, including Naphthols, Fast Salts, Nitrosamines and Rapid Fast Salts, Rapidogens	4	2
F.I.A.T.			
889	Urea Manufacture at the I.G. Farbenindustrie Plant at Oppau.	3	2
891	Duxochrome Photo Colour Prints.	4	8

Classified List No. 2 of Industrialists' Reports on Germany (Consolidated list of all reports published up to and including October 26th, 1946), price 6d. (post free 8d.).

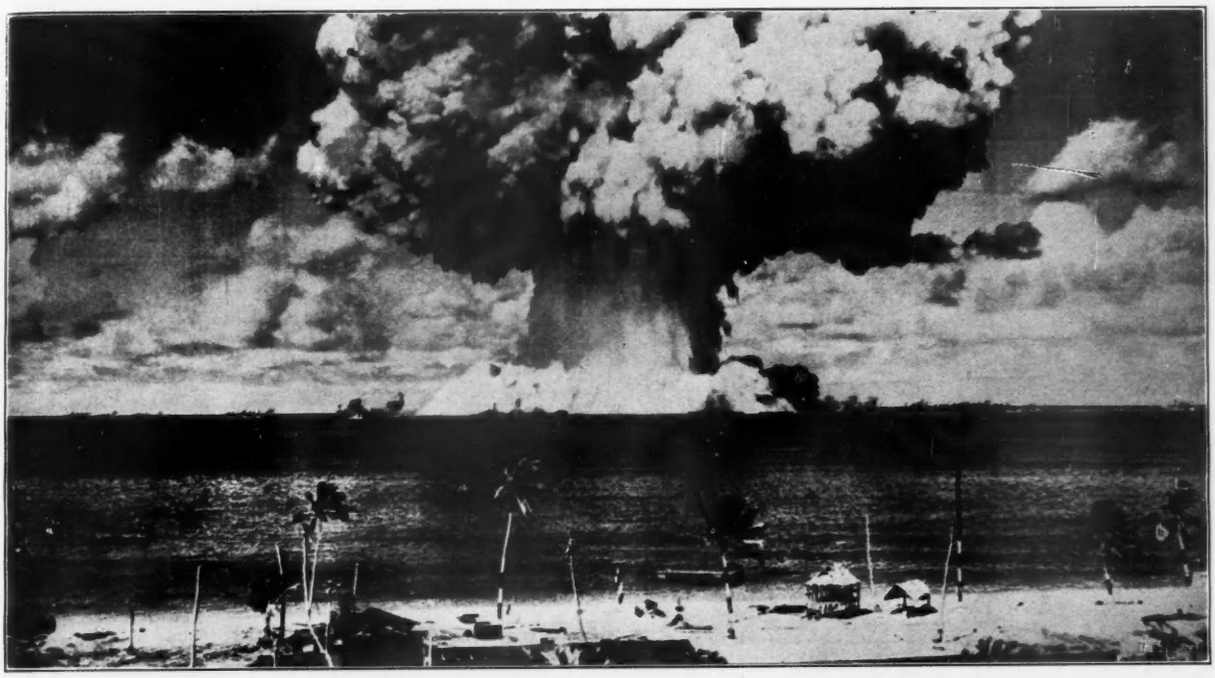
Technical Index of Reports on Germany Industry (reports published up to and including July 27th, 1946), price 5s. (post free 5s. 3d.).

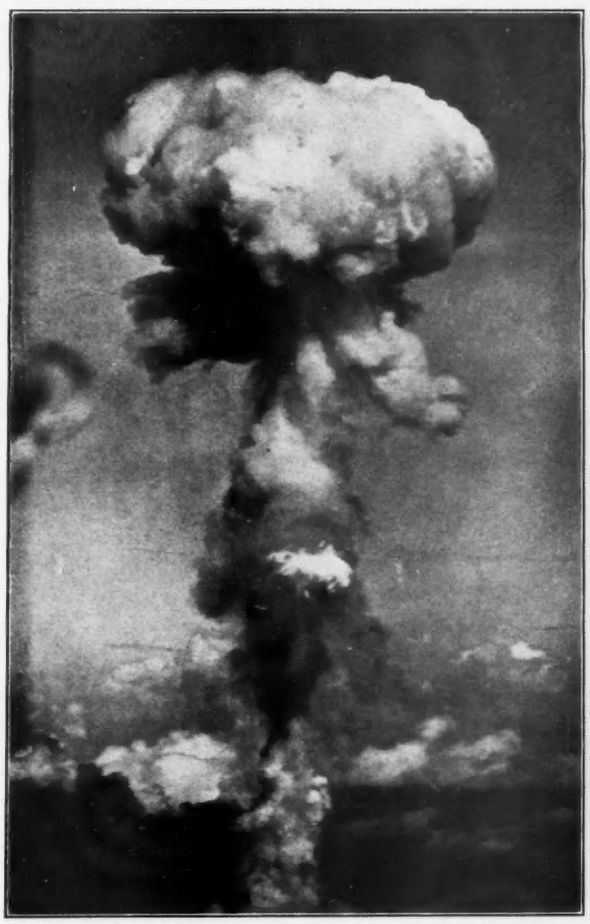
B.I.O.S.			
998	Investigation into the Design and Performance of the Volkswagon or German People's car.	12	4
F.I.A.T.			
432	The Manufacture of Refractories and Information concerning their use in the Iron and Steel Industry of Western Germany...	12	10
718	Fertilisers made by I. G. Farbenindustrie A. G. at Leuna and Piesteritz	5	2
720	German Techniques for Handling Acetylene in Chemical Operations	11	3
724	Miscellaneous Chemical Processes and Plastics Machinery	4	2
743	"K-3" Silicon Dioxide for Rubber Filler	1	7
746	Synthetic Mica Research	2	2
773	Titanium Products in Germany	5	8
774	Anhydrous Chlorides Manufacture	3	2
787	Precious Metal Refining and Fabrication	2	8
806	Gesellschaft fuer Linde's Eismaschinen (Linde-Frankl Oxygen Apparatus) Hollriegelskreuth ...	1	7
831	Sodium Sulfate Electrolysis with a Mercury Cathode	2	8
832	Hydrochloric Acid Electrolysis at Wolfen	1	1
833	Experimental Production of Chlorine by Oxidation of Hydrogen Chloride: I. G. Farbenindustrie, Oppau	2	2
844	German Concrete Shipbuilding during the war	2	1
860	The Production of Mono-Vinyl-acetate	3	8
866	The manufacture of Luvitherm Film: Unplasticized Polyvinyl Chloride Film	2	2
870	The Production of Styroflex Film: Oriented Polystyrene Film	2	1
REPORTS OF INDUSTRIAL TEAMS' VISITS TO GERMANY			
C.I.O.S.			
XXVIII-21.	German Submarine Rotary Wing Kite	2	8
B.I.O.S.			
33	The German Electric Lamp Industry	2	1
410	Some Electrical Factories in Berlin-British Zone	3	8
691	Some Aspects of Microbiological Research in Germany	1	7
696	The Manufacture of Phosphate Esters at Bitterfeld	2	1
731	Manufacture of Carbon Tetrachloride at I. G. Farben, Bitterfeld	4	2
734	German Brown Coal Industry ...	5	2
778	German Manufacture of Wires and Strips for Electrical Heating	2	8
797	The German Metal Rectifier Industry	2	2
821	Heavy Forging Equipment: Notes on German Heavy Hydraulic Forging Presses	3	2
860	Iron Powder: Notes on German Production Methods at Dusseldorfer Eisenhuetten-gesellschaft, and Deutsche Eisenwerke	2	1
876	Coke Oven Gas Separation by Linde: I. G. Oppau...	0	7
882	Aluminium Foil Production ...	3	2
896	The Manufacture of Zirconium-Potassium Fluoride, Zirconium Oxide and Zirconium Oxychloride	0	7
908	Manufacture of Products from Powdered Metals	2	1
913	Gas Meters in the British Zone of Germany and in Berlin... ...	8	3
926	Moulding Powders and Laminated Sheet: Interrogation of Dr. Eisenmann of Dynamit A. G. Troisdorf at Beltane Schools, S.W.19	1	1
928	German General Rubber Goods Industry: Part 2. For Part I see B.I.O.S. 349...	23	11
930	Preparation of Zinc by Electrolysis: Duisberg Kupfer Huette, Duisberg	1	7
935	I. G. Farbenindustrie, Ludwigshafen am Rhein: Manufacture of Phthalic Anhydride	1	1
962	Production of Tungsten Wire and Processing of Scheelite ...	4	8

B.I.O.S. Information Section, 37, Bryanston Square, W.1, which has at its disposal a considerable volume of information not in a form suitable for general reproduction, is prepared to receive enquiries regarding all problems relating to scientific and technical intelligence on both German and Japanese industry.

END OF VOL. CLXXXIII

ATOMIC BOMB EXPLOSIONS AT BIKINI

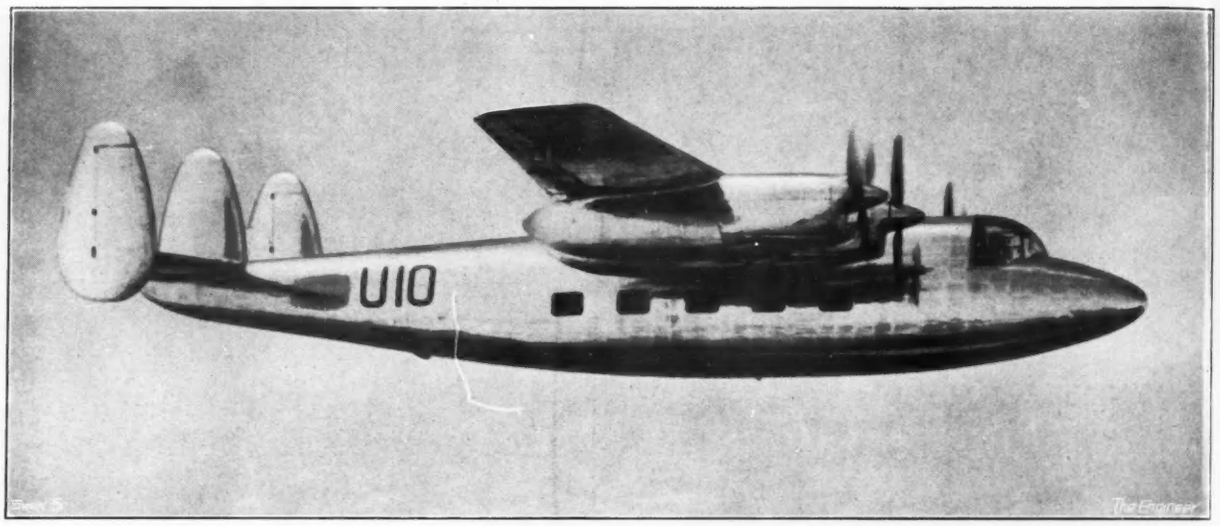


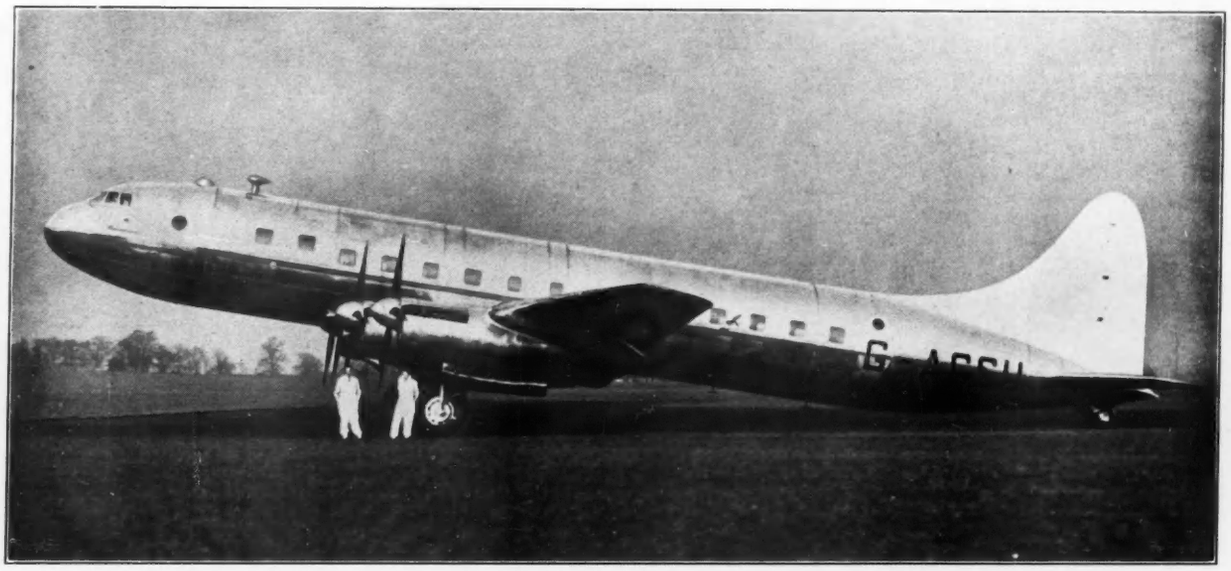


UNDER-WATER EXPLOSION

RADIO-ACTIVE CLOUDS AFTER AERIAL EXPLOSION

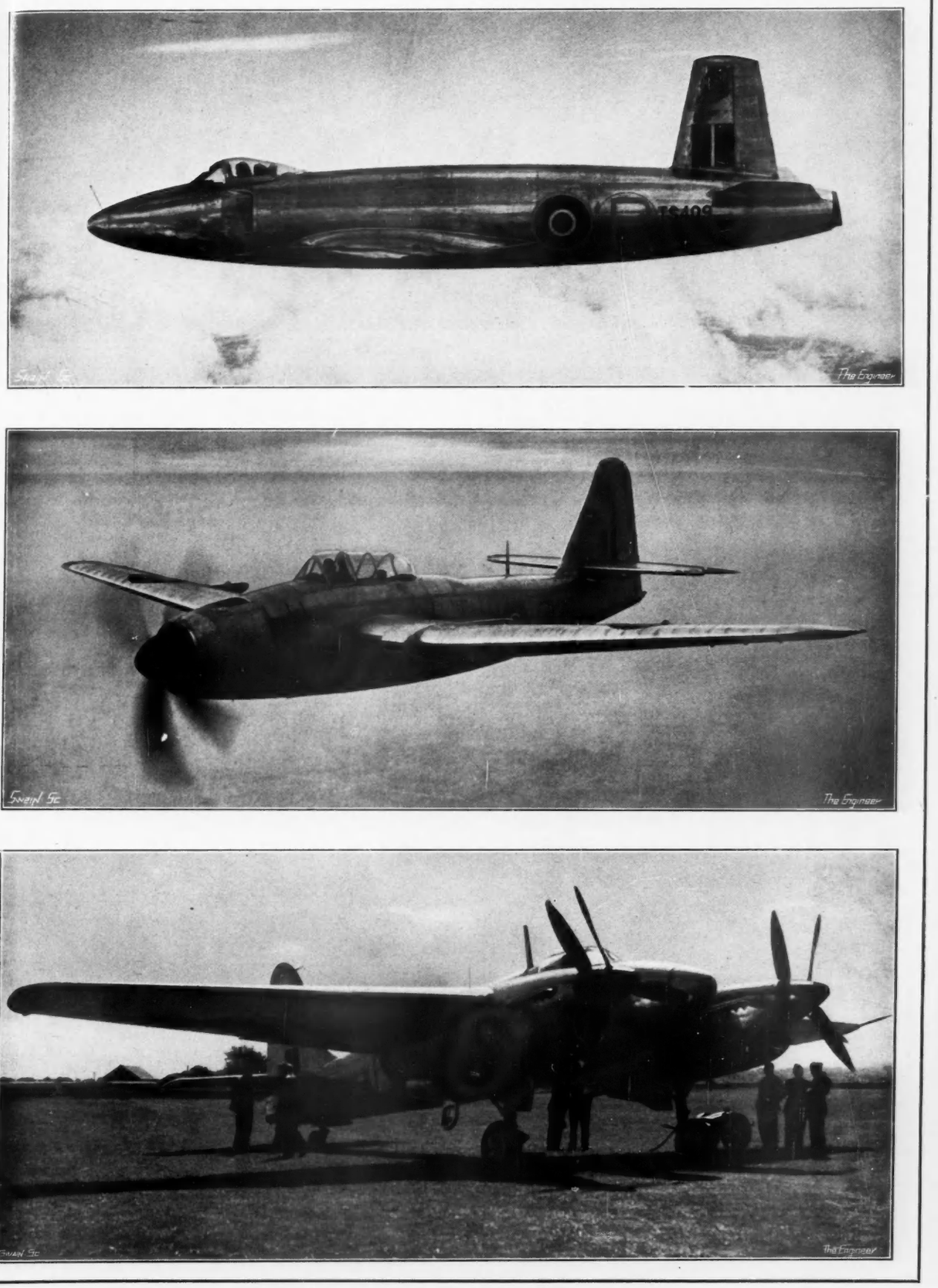
CIVIL AIRCRAFT OF 1946





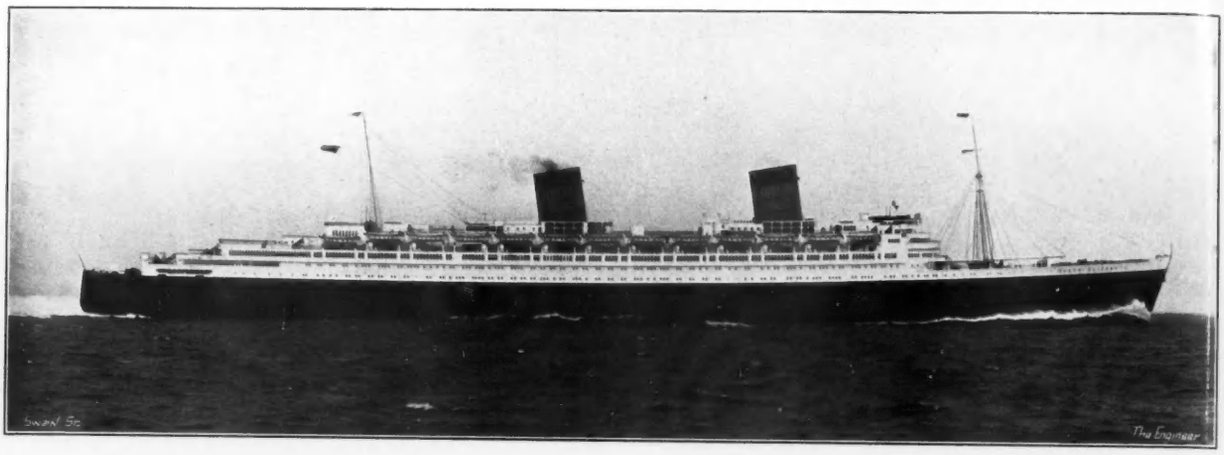
MILES "MARATHON" FOUR ENGINED MEDIUM AIR LINER
HANDLEY PAGE "HERMES" FOUR ENGINED AIR LINER
AVRO "TUDOR II" FOUR ENGINED AIR LINER

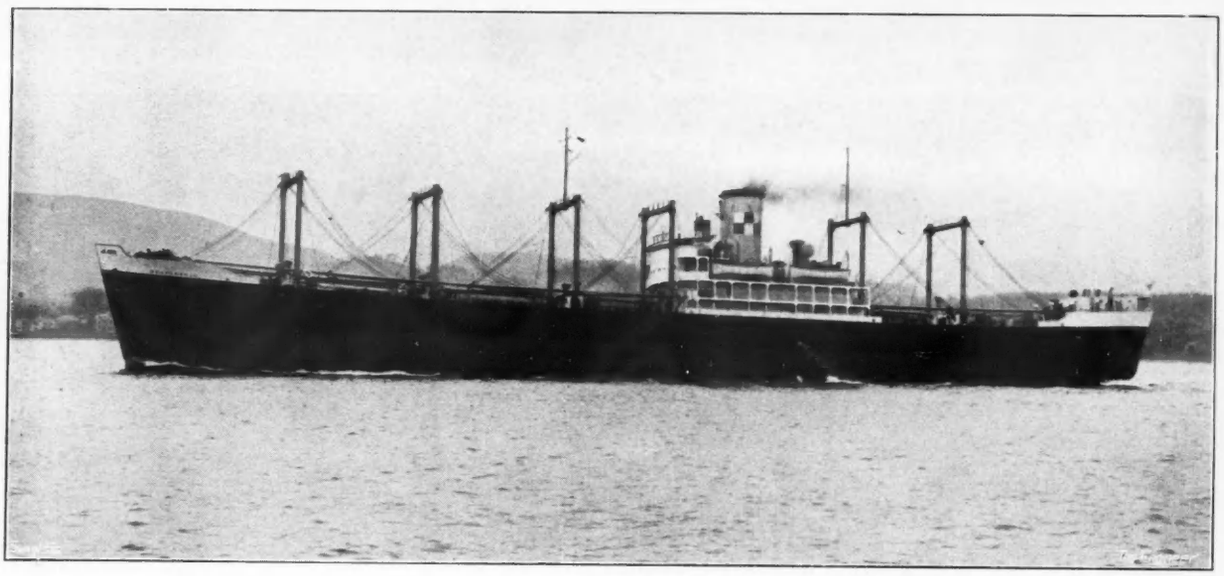
MILITARY AND NAVAL AIRCRAFT OF 1946

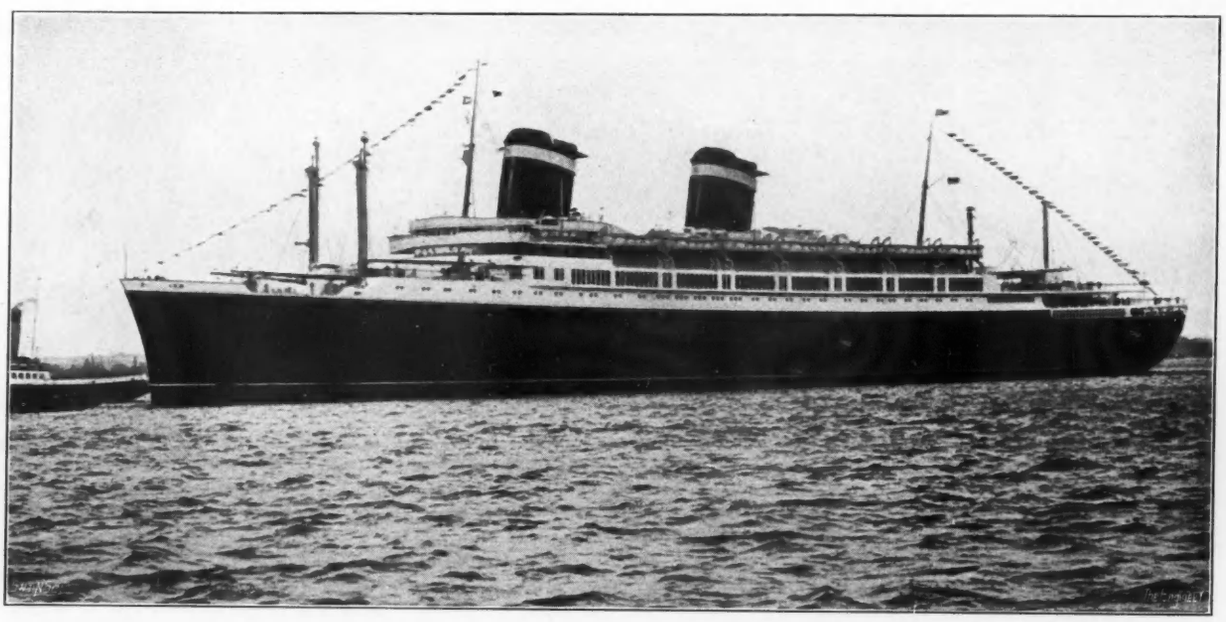


VICKERS-ARMSTRONGS SUPERMARINE JET FIGHTER
FAIREY "SPEARFISH" NAVAL TORPEDO AND DIVE BOMBER
SHORT "STURGEON" NAVAL RECONNAISSANCE BOMBER

PASSENGER AND CARGO LINERS IN 1946

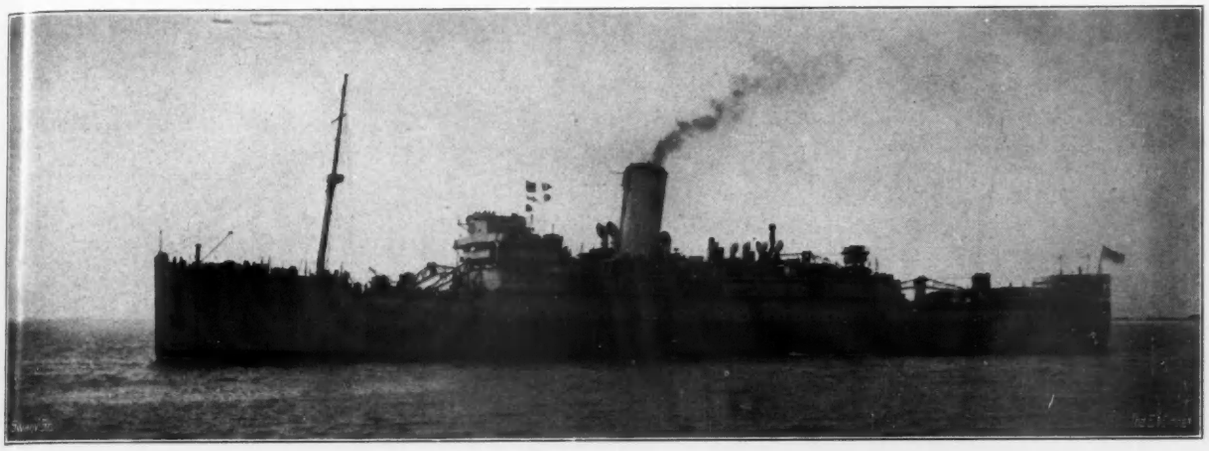


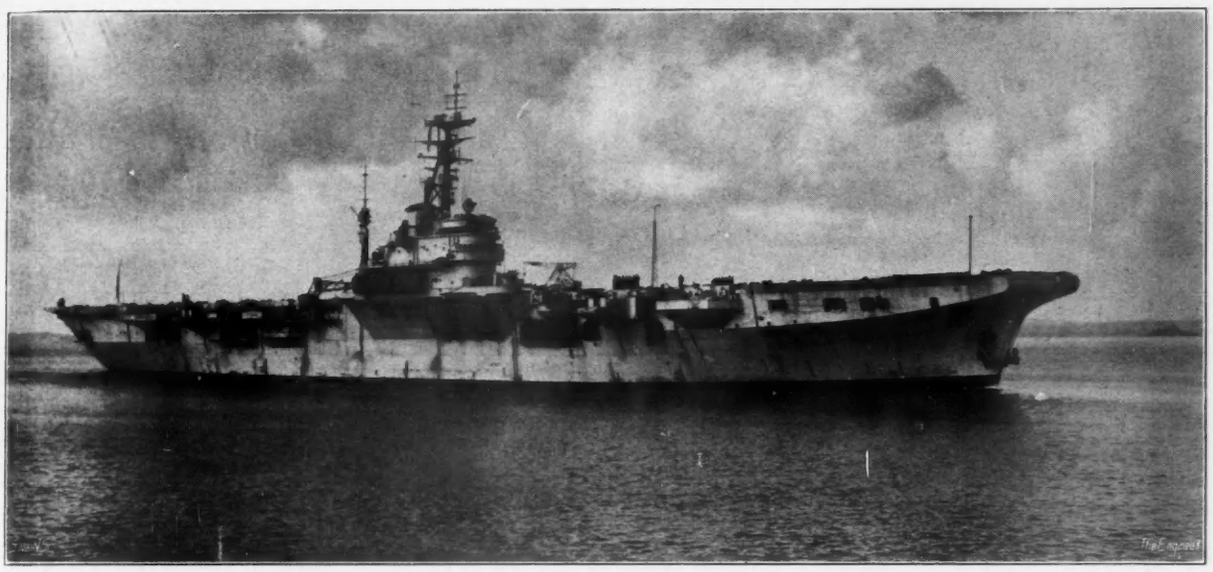


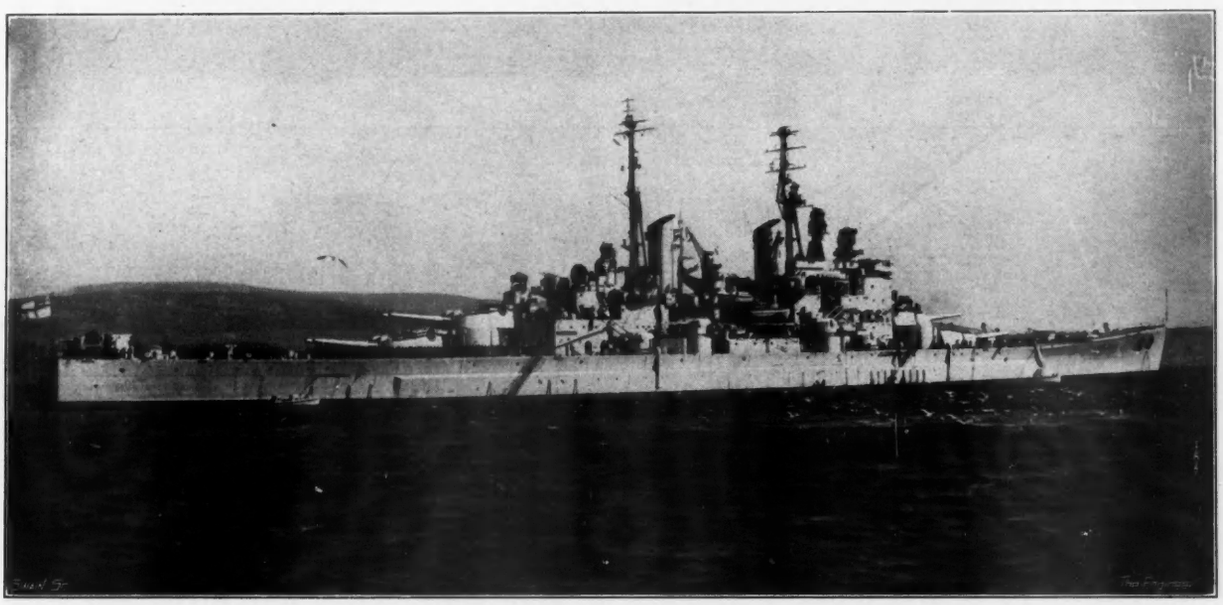


CUNARD WHITE STAR LINER "QUEEN ELIZABETH"
C.P.R. CARGO LINER "BEAVERDELL"
UNITED STATES LINER "AMERICA"

BRITISH WARSHIPS IN 1946





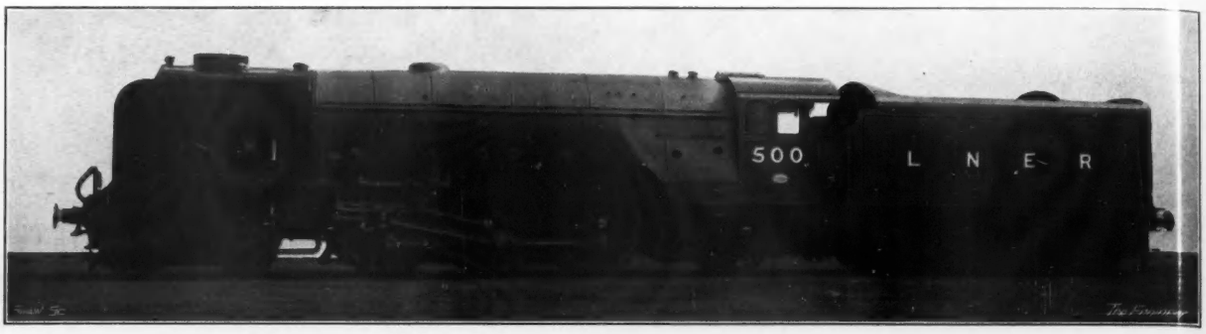


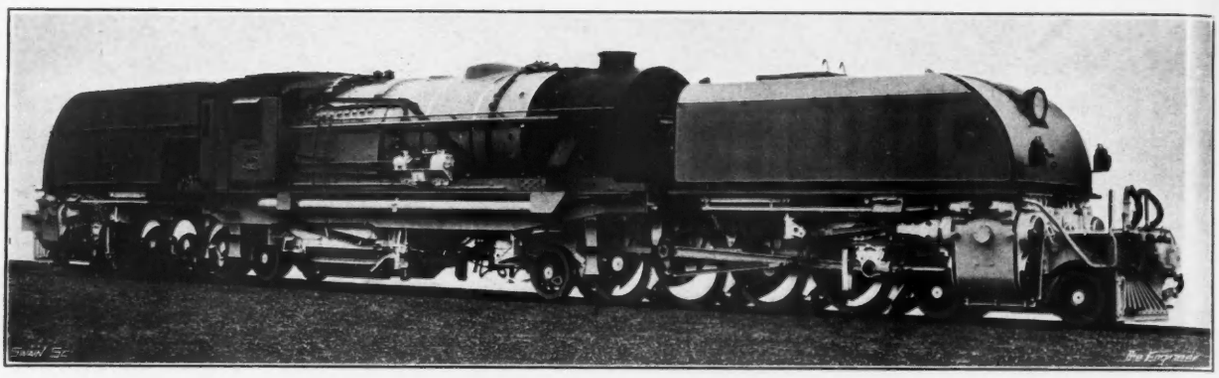
H.M. DEPOT AND REPAIR SHIP "RANPURA"

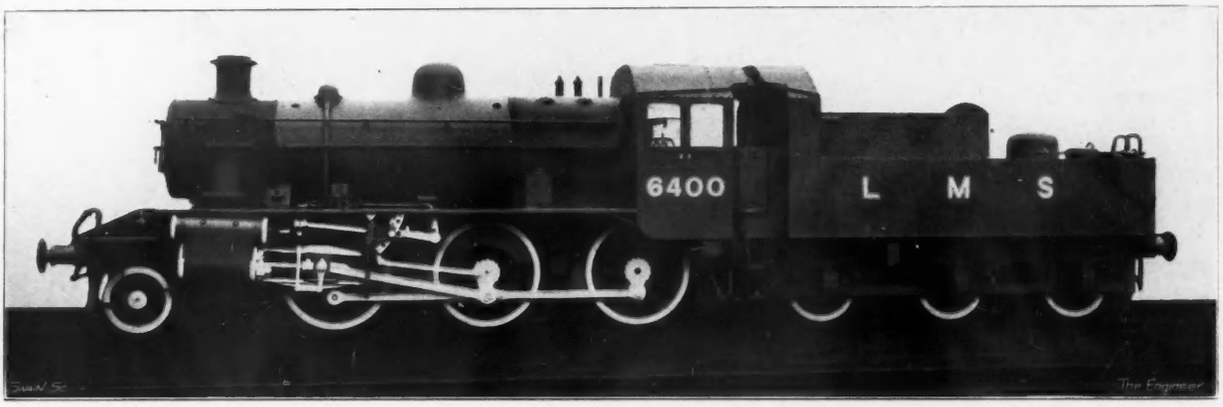
H.M. LIGHT FLEET AIRCRAFT CARRIER "TRIUMPH"

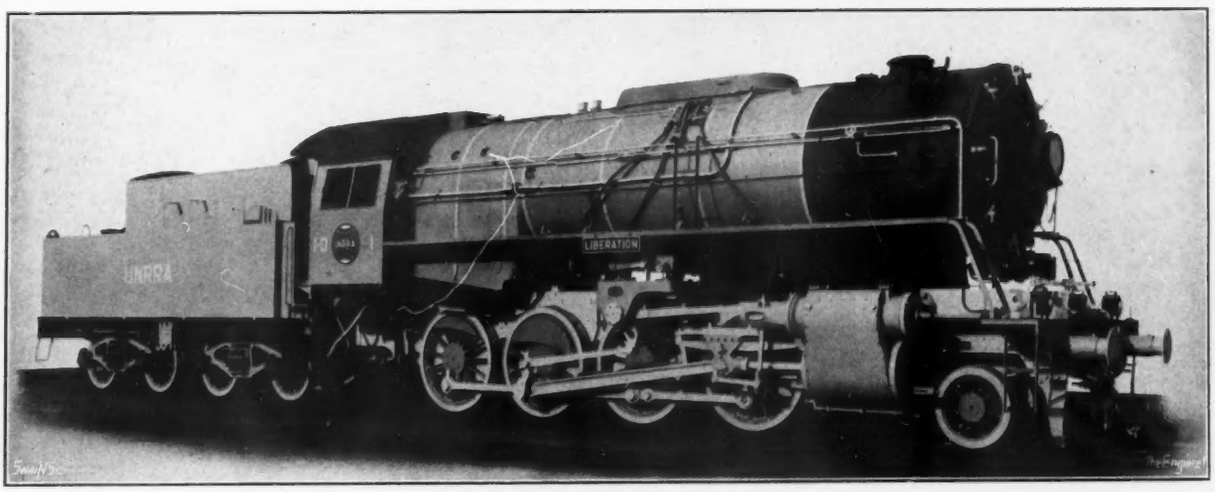
H.M. BATTLESHIP "VANGUARD"

LOCOMOTIVES OF 1946



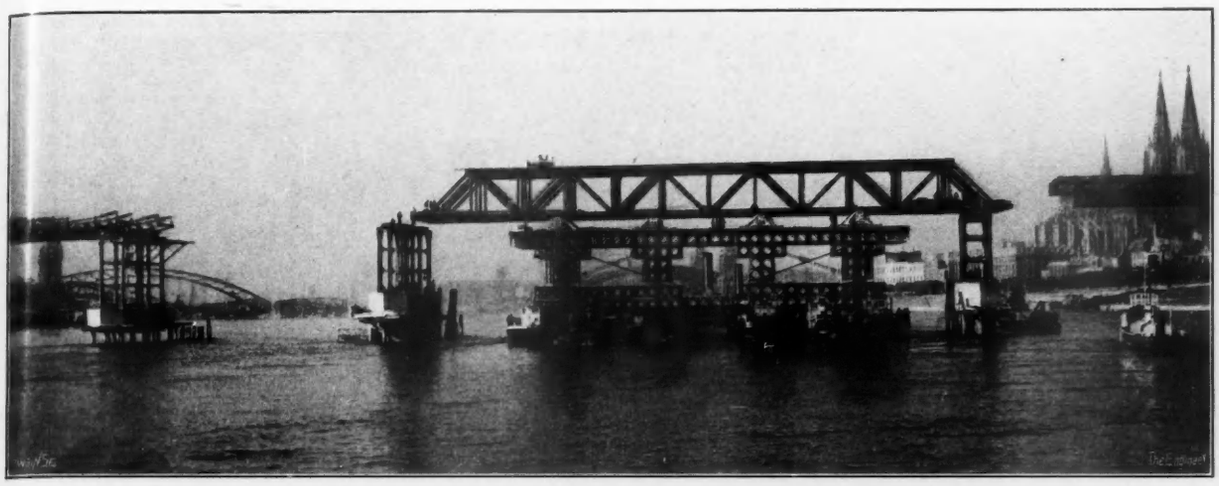


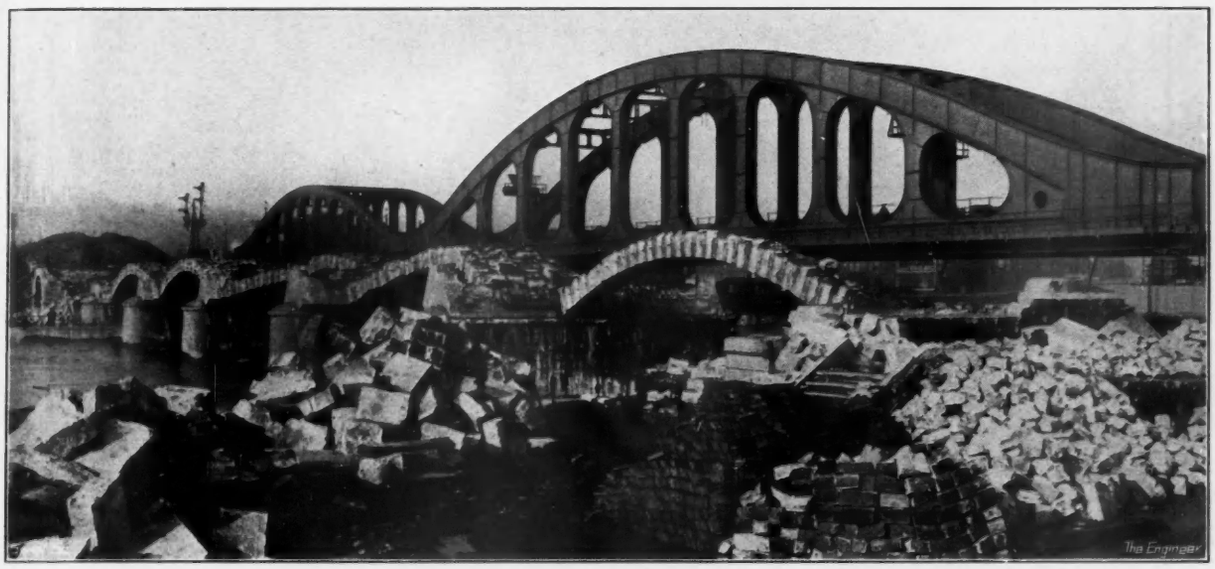




L.N.E.R. SIX-COUPLED PASSENGER LOCOMOTIVE
S.A.R. BEYER-GARRATT GENERAL PURPOSE LOCOMOTIVE
L.M.S. SIX-COUPLED SECONDARY SERVICES LOCOMOTIVE
U.N.R.R.A. EIGHT-COUPLED "LIBERATION" LOCOMOTIVE

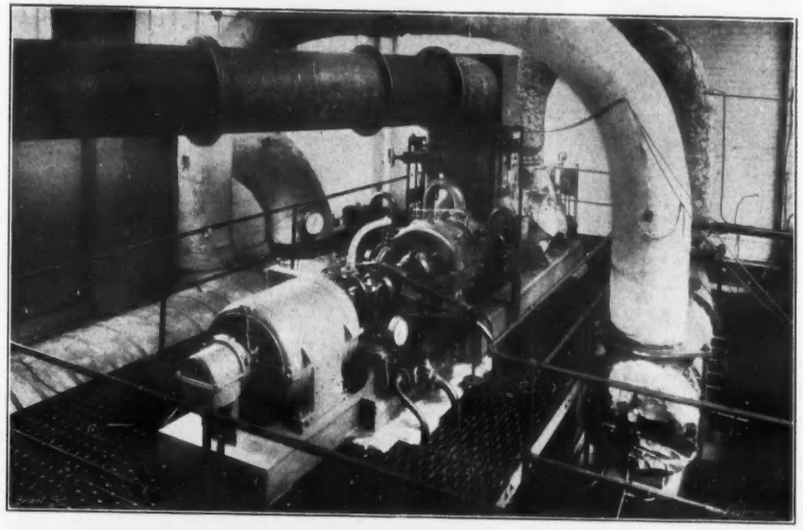
BRIDGE RECONSTRUCTION IN EUROPE—1946

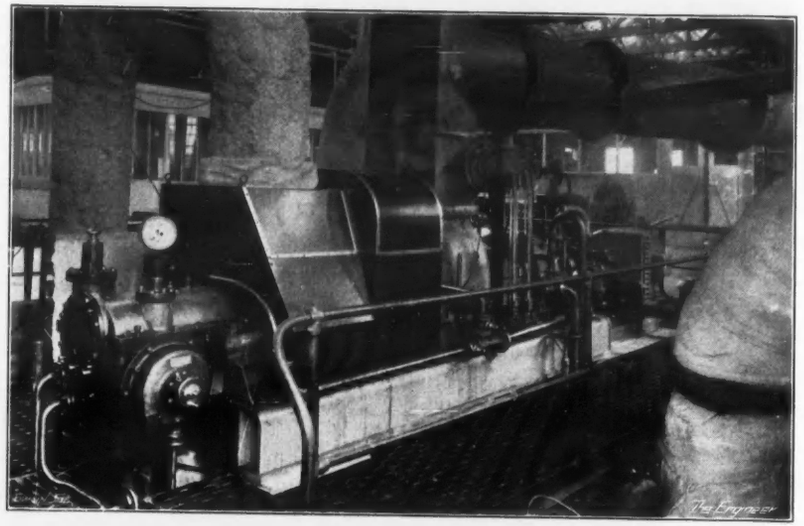


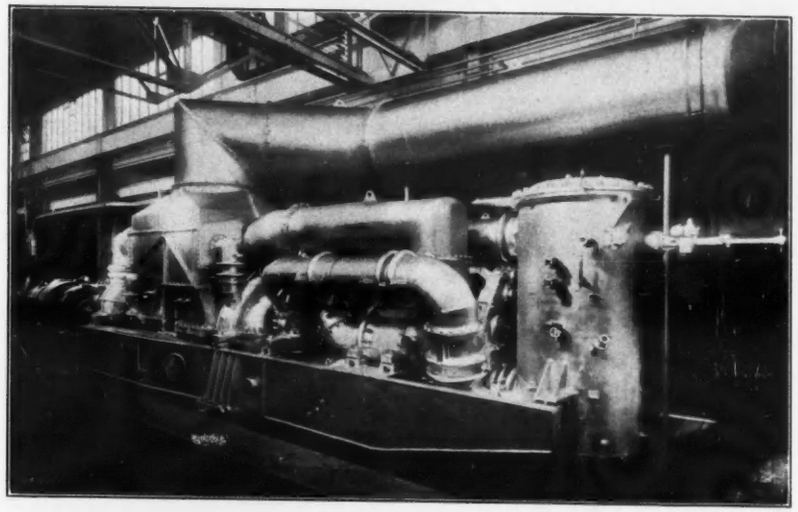


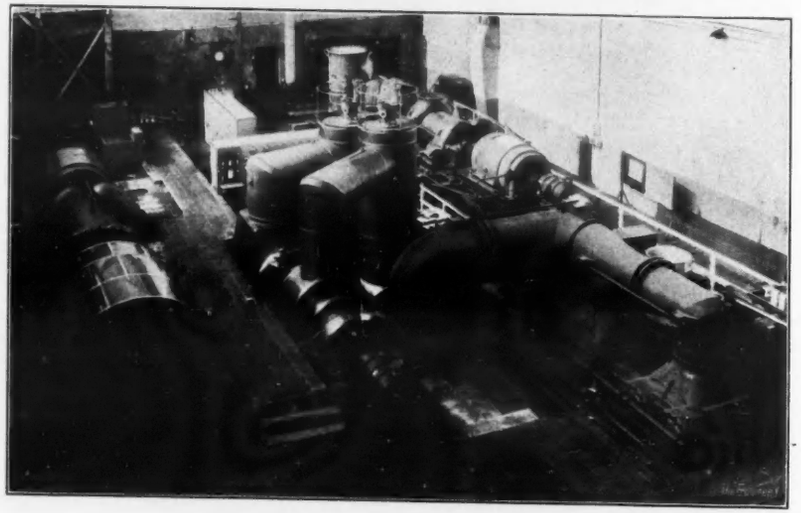
PATTON BRIDGE OVER THE RHINE AT COLOGNE
VAL-BENOIT BRIDGE OVER THE MEUSE AT LIEGE
GALLIENI BRIDGE OVER THE RHONE AT LYONS

GAS TURBINES IN 1946









PARSONS 500 H.P. RESEARCH AND DEVELOPMENT PLANT

BROWN BOVERI 4000 H.P. LOCOMOTIVE PLANT

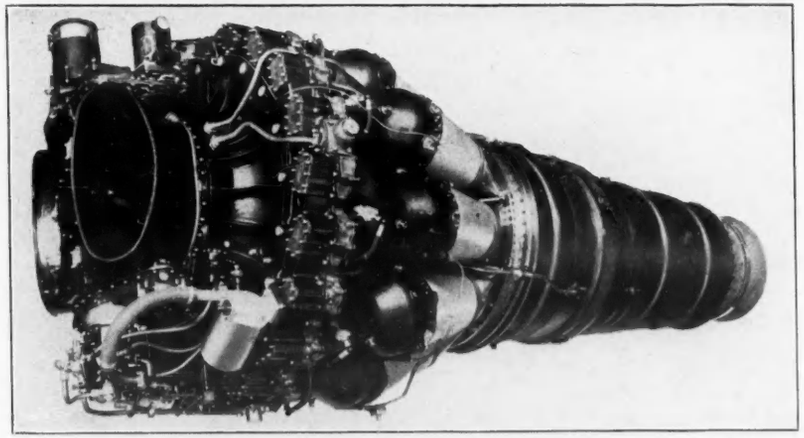
BROWN BOVERI 10,000-KW PLANT ON TEST

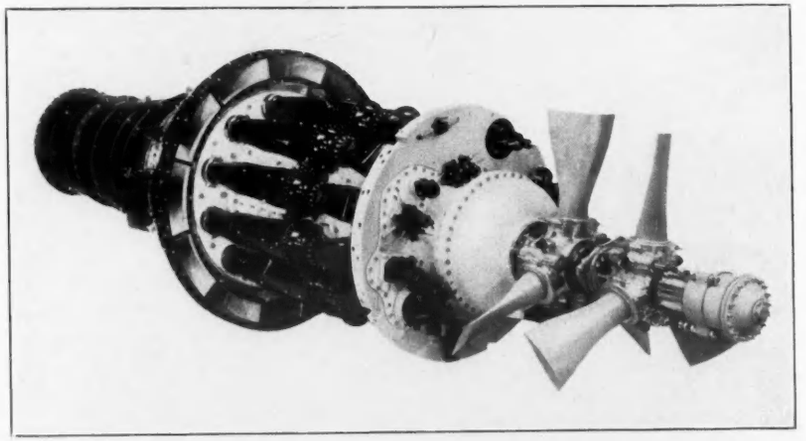
GAS TURBINE AERO ENGINES OF 1946

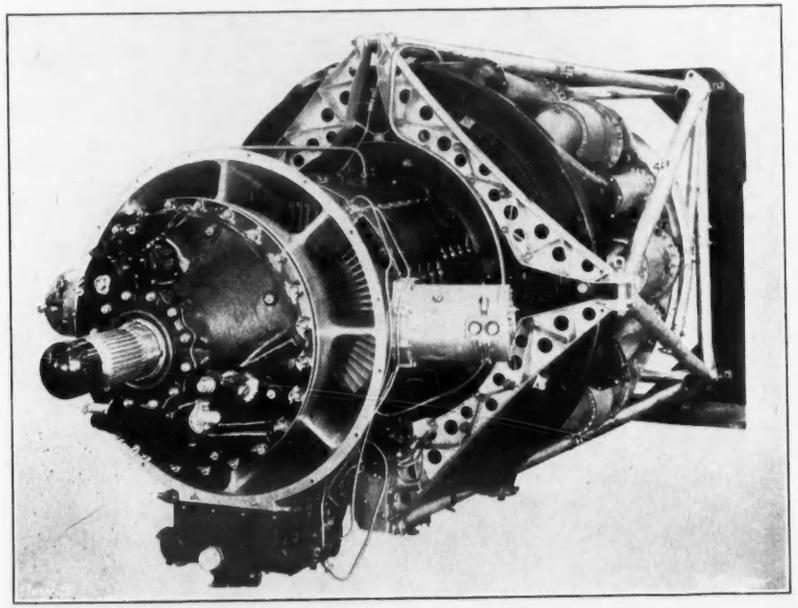
BROWN BOVERI 4000 H.P. LOCOMOTIVE PLANT

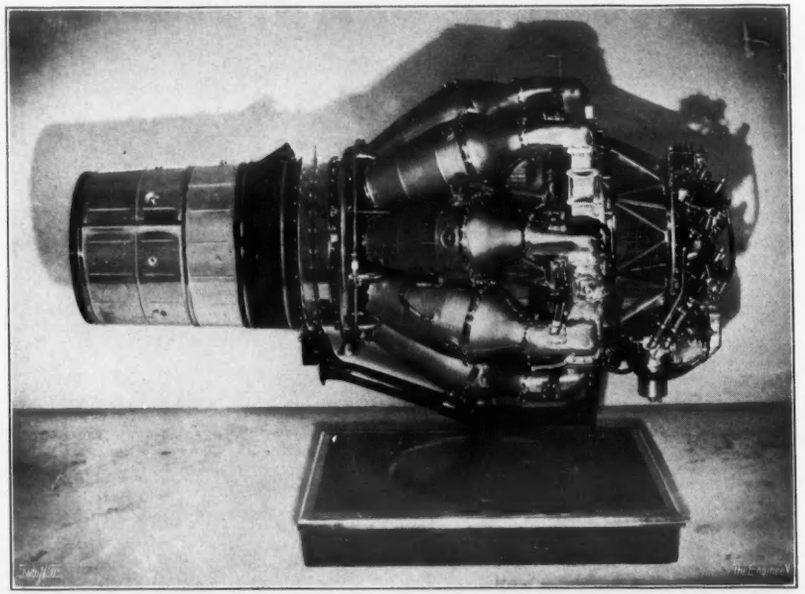
BROWN BOVERI 10,000-KW PLANT ON TEST

GAS TURBINE AERO ENGINES OF 1946









DE HAVILLAND "GHOST" JET ENGINE

BRISTOL "THESEUS I" TURBINE-PROPELLER ENGINE

ARMSTRONG SIDDELEY "PYTHON" TURBINE-PROPELLER ENGINE

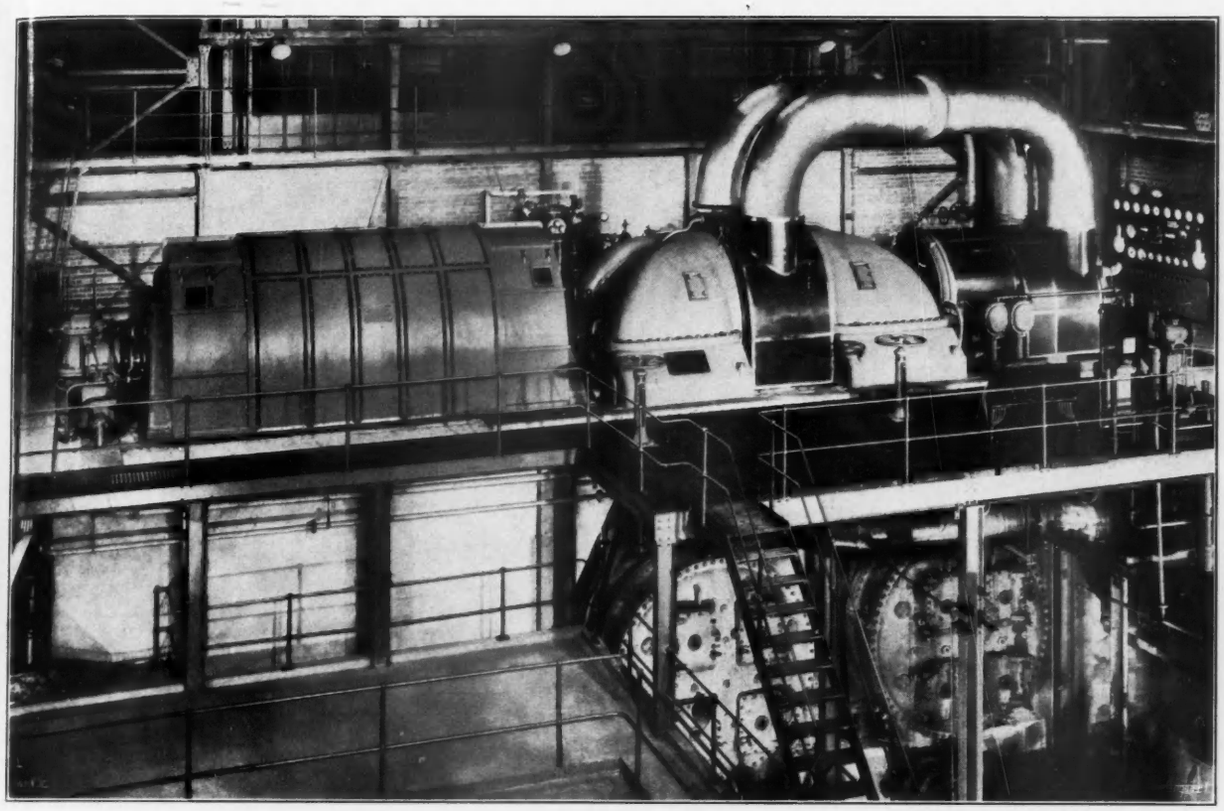
ROLLS-ROYCE "NENE" JET ENGINE

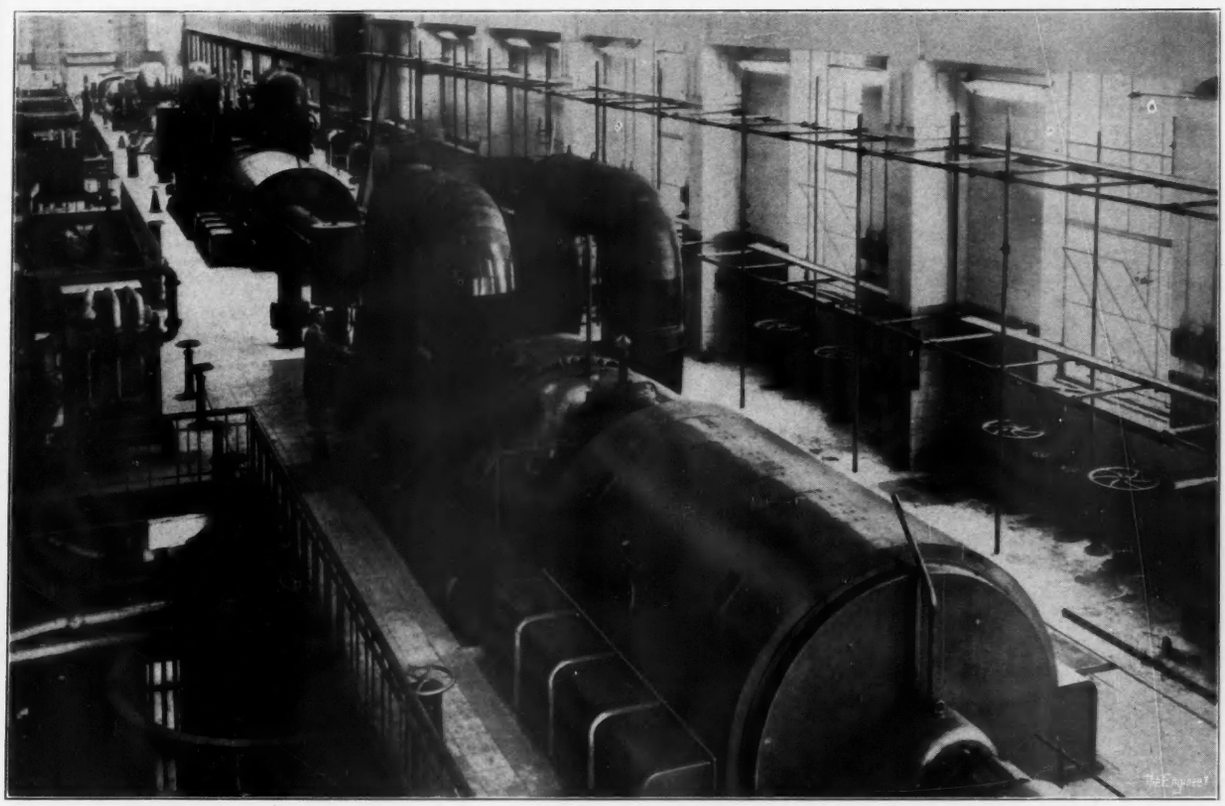
MODERN WARSHIP EQUIPMENT

U.S. CRUISER "HELENA"

H.M. BATTLESHIP "HOWE"

TURBO-ALTERNATORS OF 1946





G.E.C. 30,000-KW SET AT SCULCOATES POWER STATION
B.T.H. 30,000-KW SET AT WILLOWHOLME POWER STATION

THE ENGINEER

JUNE 27, 1947

VOL. CLXXXIII No. 4770

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ELECTRONIC ENGINEERING

Morgan Brothers (Publishers), Ltd., Proprietors of THE ENGINEER, THE IRONMONGER and THE CHEMIST AND DRUGGIST, announce that they have acquired the monthly periodical ELECTRONIC ENGINEERING (incorporating Electronics, Television and Short-Wave World) from the present owners, Hulton Press, Ltd.

Morgan Brothers (Publishers) Ltd. will be responsible for the publication of ELECTRONIC ENGINEERING commencing with the August issue. All correspondence after July 1st should, therefore, be addressed to ELECTRONIC ENGINEERING, 28, Essex Street, Strand, London, W.C. 2. The Editor and the Staff will continue to serve the paper under its new proprietorship.

NOTICE TO READERS

All letters intended for insertion in THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.

For Subscription Rates, see page 2 of Advertisements.

Mr. ALDOUS HUXLEY AND APPLIED SCIENCE

APPLIED science has never lacked opponents. Some have assailed it with the tongue, some with the pen, some with the brick and firebrand. But it has continued to go upon its way; doing its little bit of temporary harm; giving a little short-lived inconvenience, but adding always in the end to those things that meet mankind's bodily needs or increase his pleasures. Were it otherwise, were applied science generally inimical to man's contentment, it would not have been tolerated. Even were the examples of its deplorable misapplication more frequent than they are, still would the advantages outweigh the disadvantages, still would mankind demand its services in ever-increasing degree. To imagine a world without applied science is to imagine the incredible; to imagine, as some have done, a world in which applied science had become static is to imagine the impossible.

Amongst its latest critics is Mr. Aldous Huxley, in an essay entitled "Science, Liberty and Peace." His *bête noire* is mass production. "The reason for this dismal state of things," he asserts, after summarising them, "is the progressive application of the results of pure science for the benefit of mass-producing and mass-distributing industry, and with the unconscious or conscious purpose of furthering centralisation of power in finance, manufacture and government." Let it be admitted that the needs of industry—particularly in these days, when full employment is a primary consideration—must be met, yet it remains true that mass production survives because it is the best way of providing the customer at home and overseas with what he wants. Fabrics, to take an instance, could not be woven or motor-cars made in sufficient quantity and at a low enough price by any other method. It is purely a technological problem, and the furthering of the "centralisation of power in finance, manufacture and government" is rarely, if ever, the primary object. Amalgamations and combines may be, perhaps generally are, effected with that as one of their purposes, but in many cases the methods of mass production have preceded such amalgamations. The plain fact is that, in appropriate cases, mass production is the best technology, and if it happens to "centralise power," that is an incident, not the motivation, of its existence. The same is true of mass distribution. The mass distribution of electricity is an example. Does anyone imagine that its first object is to concentrate power in the hands of the Central Electricity Board and not the satisfaction of the public? It is not to be denied that the accumulation of power by private corporations or by Governments may be carried too far, but it is unfair to put the blame on the applications of pure science for their misuse. Mr. Huxley, like many others of the present day, have a horror of power and a dislike of authority put over them. But surely it is not power itself, but how it is used that matters. In mass production and mass distribution the power is ordinarily exerted beneficently. Mr. Huxley's objection to "power" and "bosses" is based on their interference with man's spiritual and psychological needs. It would, perhaps, be not unfair to say that he dislikes the application of science by mass production methods because it is efficient, not because it is applied science.

Whilst we have joined issue with Mr. Huxley on points of fact, we do not deny that in some degree our sympathies draw us to his side. His remedy for the ills he sees is that inventors and technicians should "apply the results of pure science for the purpose of increasing the economic self-sufficiency and consequently the political independence of small owners, working either on their own or in co-operative groups, concerned, not with mass production, but with subsistence and the supply of a local market." The vision of a small, self-contained, self-satisfying community living a peaceful existence, undisturbed by the rattling of the world around it, has inspired many thinkers and a few experiments. Experience has shown that it can only be worked on the smallest scale. Pleasant as the contemplation is of a world in which every man would be exclusive master of his own soul, we have to face the fact that circumstances are driving mankind to ever greater interdependence and to ever greater reliance upon the material things that applied science alone can provide. From that there is no escape. Mr. Huxley's plan does not open a way out. All that can be done, and that perhaps will be done, is to control and direct the ingenuity of scientists and engineers that they may make the bonds of civilisation as little irksome as possible.

LIMITATIONS

TO-DAY we are beset by limitations. Coal and steel are in short supply. Lack of timber holds up more than the construction of houses. Food is scarce and rationed. Electric power is subject to winter "cuts." Labour clings to restrictive practices. Controls, far from becoming fewer seem still to multiply. Restrictions upon every hand affect our capacity to work and to produce. We can find no good word for limitations. We are tempted to draw the sweeping general conclusion that they are always bad. Yet is that generalisation really true? Do we really wish to see all limitations removed? In our engineering work, for instance, we suffer many restrictions. Design and practice is bound and fettered within the limited strengths of materials. It is held down by the need to allow for the effects of thermodynamic laws, of inertia in its various forms, of difficulties of heat transmission and of many other factors, scientific and practical. Are such limitations always bad? Surely not! For how very inefficient and chaotic a world it would be if many of the dreams we set afloat as students had not foundered irredeemably upon just such rocks of natural law and engineering practice, just such limitations!

In truth, the less fettered we are in design the more difficult, not the easier, it becomes. If but a single material is available for a certain purpose we are at once relieved of the responsibility of making a choice between alternatives. Further, we can afford the time to study that material in detail and, becoming wholly familiar with its qualities, use it in such a way that both its strengths and its weaknesses are subtly bent to our purpose. But how can we do as much when a hundred differing materials are offered? How can we feel certain that our choice is necessarily the best and that we have made the best use of the chosen material? How even more complicated and impossible the position becomes when each year new materials with new characteristics are added to the throng. Of the great outpouring annually before our engineering societies of technical papers on this matter and on that how much lies fallow? For on every hand we hear complaint not of a general lack of material but that there is too much! It is impossible to keep pace even in a self-restricted field with the amount of knowledge annually published. In this way we are brought face to face with a limitation

more fundamental than any other. Despite the great weight of human knowledge that has been accumulated across the centuries, despite the complexity of the organisation of modern cities as compared with those of the past, there is no evidence whatever that the minds of modern men are one whit less limited than those of ancient Greeks, Romans or Egyptians. These foreigners, of ancient times, seem, when read about, as ordinarily human as our twentieth century friends familiar to us through our everyday contacts with them. Man has not changed, seems not to have evolved at all within the last two thousand years. All the advantage we have to-day over the men of ancient times lies in a greater wealth not of mental capacity but of factual and theoretical knowledge. We have, in fact, exaggerated the contrast between the totality of man's knowledge and his very limited capacity to absorb more than a part of it. How far can the contrast be carried without disaster?

In the past we have depended very largely for engineering advancement upon the works of individual men of genius and inspiration, Watt, Trevithick, Murdoch, Penn, Whitworth and Parsons, to name but a very few of them. But we fear that now in the middle of the twentieth century it is no longer possible, even within the narrow limits set by mechanical engineering, that a single mind can grasp all or nearly all that is necessary for the achievements of its purposes. Is it not significant that there is no name indisolubly connected with the development of radar to set beside that of Marconi in wireless telegraphy? Who was the inventor of the atom bomb? The name of Whittle is, it is true, peculiarly associated with the development of the aircraft gas turbine. But in the sense we use the term of Watt and Stephenson and Parsons, Whittle is not an inventor. Rather, his enthusiasm and boldness became the driving force behind a team of specialists developing to practicality an otherwise well-known device. For to-day, it seems, the work of engineers has become a matter so complex that it far surpasses in many fields the limited capacity of any single intelligence. Research and development must now be carried out by teams each member of which has detailed firm knowledge only about his own particular field. Physicists, chemists, mineralogists, metallurgists, even botanists and zoologists and other scientists must be associated with engineers in carrying out investigations and making reports. Committees in the past were limited in function to management. Now it seems committees must do the actual research work! That is the practical solution that engineers and scientists have devised to meet the problem set by the limited capacity of the human mind. Is it we wonder an effective answer? In the past we relied for advances upon the peculiar qualities of men of genius. Can genius shine in committee? Can a committee stimulate genius? Can its composite mentality transcend that of the individual intelligences that comprise it? Upon the answers we feel able to make to such questions will depend our opinions about the future rate of advancement of engineering theory and practice.

Literature

The Newcomen Society Transactions. Vol. XXII. 1941–42. Published by the Society, 43, King's Road, London.

It is pleasant, indeed, after an interval of several years imposed by war restrictions, to see a volume of the "Transactions" of the Newcomen Society in its familiar form and type and of almost as good quality as ever. These "Transactions" have an air, becoming in the works of an antiquarian body, that distinguishes them from all others, and we trust that the English edition will continue to maintain its personality and not seek modernisations or endeavour to popularise itself by the arts of the publicity expert. When dealing with modern affairs it is fitting to be modern; but when concerned with the past, a certain antique dignity is becoming.

The present volume covers the session 1941–42 and includes many attractive papers besides another instalment of the Analytical Bibliography of the History of Engineering and Technology. We are pleased to see a note on the beginnings of the Society by one of its principal initiators and its first President, Mr. Arthur Titley, written on the attainment of its majority. This little page of history had never before been printed, and Mr. Titley has presented it charmingly. The only omission is a reference to the origin of the motto and crest of the Society. The motto was written offhand by the late Mr. E. Kitson-Clark at a committee meeting of the Institution of Mechanical Engineers! It was subsequently submitted to the scrutiny of two classical authorities and on their approval was adopted. It is well that a world devoted so much to the present and the future should be reminded that looking back on the great past may help us on our forward path. As one of the *philosophes* of the eighteenth century remarked, "He will never think of posterity who never thinks of his ancestors."

We note also another little paper that was much wanted. Many engineers are familiar with Stuart's delightful duodecimo volumes of "Anecdotes" of steam engines and engineers, but few know anything about the author, Robert Stuart Meikleham. Mr. H. W. Dickinson and Mr. A. A. Gomme are to be thanked for collecting the facts about his life and works. Mention must be made also of the Presidential Address by Colonel C. E. Davies, an American member, entitled "What's Past is Prologue." It was fittingly written to celebrate the majority of the Society. It throws some light on the development of the Society in America and upon the course it is taking there.

Another very welcome paper is entitled "The French Civil Engineers of the Eighteenth Century," and was contributed by Mr. S. B. Hamilton, M.Sc. We know all too little about French engineering, and Mr. Hamilton's paper, a mere sketch as it were, may tempt some to follow the matter into greater detail. He tells us that civil engineering as a profession had its birth in eighteenth century France and reminds us of Telford's interest in French technical literature and of his gift, when first President, to the Institution of Civil Engineers of his library, amongst which were many French works.

Fourteen papers are reprinted in this volume, and we cannot give the space even to name them all, but one more, because it opens a new field for the technical historian must be mentioned. It was written by Dr. Herbert Chatley, is entitled "The Development of Mechanisms in Ancient China," and was, very fittingly, read in the Royal Asiatic Society's rooms.

SHORT NOTICES

Workshop Calculations for Machine Tool Operators. By G. Williams, B.Sc. London: Sir Isaac Pitman and Sons, Ltd., Parker Street, W.C.2. Price 10s. 6d. net.—In this book the basic principles of machine tool operations, together with formulæ and methods of solving problems, have been set out in a clear, concise manner which any operator with a reasonable knowledge of mathematics will find easy to follow. A wide field of application has been covered and the book will be both instructive and of considerable practical use, not only to machine tool operators, but also to students and teachers.

Conveyors and Cranes. By W. H. Atherton, M.Sc. London: Sir Isaac Pitman and Sons, Ltd., Parker Street, W.C.2. Price 25s. net.—This book is divided into three main sections. The first part deals with the mechanical handling of goods in package form; the second with the handling of loose materials; and the third with cranes of several types. Each type of mechanical appliance is dealt with in a clear concise way and the facts on the essential features of design are supplemented with data, tables and drawings where desirable. This book will be a useful guide to those contemplating the installation of a mechanical handling system, as well as to draughtsmen and designers concerned with the selection and application of conveyors and lifting appliances.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

L.M.S. DIESELS

Sir,—In your issue of May 9th, you published a letter from Mr. Brian Reed, in which he implies that although locomotive engineers are aware that the straight diesel locomotive has great advantages over the diesel-electric locomotive, they are doing nothing about it. As this is not the case, a reply is necessary on behalf of British locomotive designers.

Railway companies throughout the world were quick to take up the diesel-electric locomotive for two reasons: first, because of the obvious advantages of the power unit, and, secondly, because the straight electric locomotive was already proved in service, as was also the diesel-electric generating equipment. On the other hand, large mechanical transmissions for straight diesel locomotives could not be said to have been proved in service, and the designer and manufacturer have had, therefore, much greater difficulty in selling their products. Progress has therefore been slow, but great progress has, nevertheless, been made.

Horsepowers are on the increase and straight diesel locomotives of 500 h.p. with simple mechanical transmissions are at present on order in this country and will shortly be in service. Personally, I have no hesitation in saying that horsepowers will continue to increase and that the next ten or twenty years will show the straight diesel locomotive superseding the diesel-electric locomotive, even in the highest powers.

Leeds, May 29th. John Alcock.

The Future of the Electricity Supply Industry*

IN this abnormal year none of the usual topics appears to be wholly appropriate since on this occasion the subject of Nationalisation transcends all else and could hardly be other than the main theme of my address. So much has been said and written about the Electricity Bill that I cannot hope to do more than underline some aspects requiring earnest consideration in the coming period of change-over and reorganisation.

The Past

To understand the present, or to make any forecast of the future, it is essential to consider the past, even if somewhat briefly.

The electricity supply industry is perhaps the youngest of our major industries. Whereas in this country coal has been mined for centuries and railways have existed for well over 100 years, public supplies of electricity have been established for little more than fifty years. Within the memory and experience of engineers still in the industry it has developed from experiment to the great public service as we know it to-day. The number of consumers has grown from a mere handful to over 11,000,000, and the invested capital in the industry now exceeds £800,000,000. Supplies have spread into the vast majority of homes, commercial premises, workshops and factories. The applications of electricity have invaded all fields from lighting and other domestic uses to traction and every branch of industry, to medicine and surgery, radio and television. No better picture of the universal use of electricity, nor grimmer realisation of what modern life would be like without it, could be provided than by reminding you of the many hardships so recently experienced when public supplies were withdrawn or restricted. It has, in fact, become, after coal, the greatest single factor in the internal economy of the country.

Despite its overwhelming importance to the national wellbeing, it is not a big industry in terms of employment. Its 120,000 personnel compare with 700,000 in coal mining and 1,400,000 in railways and other forms of transport. It was one of the first, if not the first, of the major industries to adopt Whitleyism as a means of negotiation of wages and working conditions, and it is noteworthy that no major strike has ever occurred.

The existing authorised undertakers comprise 365 local authorities, 195 companies, and eight joint authorities. Their general powers are contained in a series of public general Acts, the consolidation or codification of which is very much overdue. Special mention may be made of the 1919 Act, which established the Electricity Commissioners, and the 1925 Act, under which the Central Electricity Board was created.

Committees set up by Parliament have investigated and reported upon the industry from time to time, the most recent of these being the McGowan Committee, which reported in 1936. This was followed by the Outline of Proposals issued by the Ministry of Transport in 1937, based on the Report and tentatively suggesting various groupings of existing undertakings. These two documents raised a storm of protest and caused much commotion in the industry, but owing to the impending threat of war, no further steps were then taken.

During the inter-war years between 1919 and 1939 the industry made phenomenal progress, the total annual output expanding practically ten-fold. Then came the recent war, which had the same uniting influence on the industry as on the nation generally. Total annual output during the war period expanded from about 21,000 million units in 1939 to over 32,000 million units in 1945.

In 1943-44 each section of the industry reported to the Minister its views in regard to reorganisation. A Joint Report which became known as the White Memorandum, contained a candid statement of the features admittedly requiring attention, and recommendations for effecting the desired improvement. The Association's own views of other aspects were submitted in a document known as the Brown Memorandum.

This very brief review of some fifty years of development brings us to the position obtaining when the war ended in 1945, which may be summarised by stating that, while recognising certain aspects in which improvements were desirable, nevertheless the industry, both company and local authority, could fairly claim :—

(*a*) A proud record of past achievement.
(*b*) An enterprising post-war programme.
(*c*) An adequate and contented personnel and
(*d*) The fullest confidence in its ability to meet all needs.

It was in this atmosphere that, in November, 1945, the Government's announcement of the intention to nationalise the industry was received.

By its very constitution and objectives, this Association has always stood four-square for public ownership. This principle is laid down time and again in our reports and proceedings. It was declared openly and firmly in the Association's Brown Memorandum of 1944.

Therefore, as a fundamental issue, the Association could not but welcome reorganisation on a basis of public ownership. The Association was concerned, however, and deeply concerned, as to the form that such reorganisation should take and as to the part which local authorities would be expected to play in it.

When it became clear that under the Government's proposals, local authorities were not to be entrusted with ownership, the utmost efforts were made to secure for them an administrative responsibility at local or district level. Though pursued diligently by memorandum and interview over a long period, these efforts have so far failed and, as members are now aware, it is anticipated that local authorities will have only a consultative role in the structure.

The Future

In considering the future many questions come rapidly to mind. What will be the position of the local authorities, the manufacturers, the contractors ? How will nationalisation affect our Association and many other kindred bodies ? How will engineers and other staff be affected, and what will be their prospects ? How long will reorganisation take, and how will the industry carry on until it is complete ? These and many other questions arise. Knowing the dangers of prophecy, I do not propose to attempt specific answers. Neither time nor space nor prudence would permit. Nevertheless, these matters are of such vital concern that they must be considered in a general way.

Nationalisation is a policy for which a good case can usually be made out in theory. It appears attractive—it is easy to visualise a co-ordinated policy, unified control, and integration with other industries. It is urged, with particular reference to this industry, that it will replace the present large number of undertakings by a smaller number of more rationally chosen units, the present multiplicity of tariffs by a more uniform code, the present divergence of voltages and systems by agreed standards. It is urged also that the working conditions, welfare and training of personnel can be improved, that research can be co-ordinated and extended, that large scale operations will bring economies in various ways and permit of wider distribution and better service. These are the ideals; the problem is to find a practical solution approaching as nearly as possible to them.

First of all, let us agree that nationalisation will not of itself work miracles. It can do no more than provide the framework and the necessary facilities, but real success depends on human factors, the most vital of which are good management, the right spirit within the industry and public goodwill. In all industries, large or small, whatever the type of organisation, success ultimately depends on the man on the job—that is why it is so necessary to have the right spirit in the industry. Further, the ultimate test of all these schemes is their effect on the ordinary consumer—that is why it is so necessary to retain public goodwill.

Accepting these factors as fundamental to the success we all desire, each of them may be examined a little further.

The New Structure

The main structure of the proposed organisation comprises the Minister, with considerable powers of direction and regulation, a central authority with financial powers and general responsibility, and area boards with rather limited autonomy and responsible in the main to the central authority. In brief, a chain of newly created public boards responsible to the Minister and through him to Parliament.

The public board is a device to secure public responsibility without incurring the risks and complications of direct state trading. Various types already exist. The main difficulty with all such bodies is to combine public responsibility with commercial enterprise, two functions which to some extent do not blend at all well. It is not easy to find the right form of organisation, but fortunately within our own industry useful experience is available. First, local authority trading undertakings have already, and in a large degree, overcome these somewhat conflicting interests. Secondly, part of the industry has operated successfully under a public board in the form of the Central Electricity Board.

Public boards fall into two general types comprising either (1) functional members, each having whole time executive responsibility for specific sections of the work, or (2) one or two whole-time members and a number of part-time members. The latter type seems more suitable for the electricity supply industry and more likely to be responsive to public opinion, to view problems dispassionately and, having decided upon policy to leave the application to executive staff who are free from sectional pressure of any kind. The intention seems to be to have bodies of this type, a choice which it is felt will be endorsed by the industry.

From the Bill it is clear that the powers retained by Parliament, through the Minister, are extensive and, if rigidly applied, could embarrass the free operations of the boards. Here it is possible to draw on our experience of the Central Electricity Board. While in fact responsible to the Minister, successive holders of that office have interfered little, if at all, with the general policy of the Board. It is to be hoped, therefore, that in his relations with the new boards, the Minister will seldom find it necessary to use his formal powers. The assurances to this effect, which have already been given, are welcomed. Next, the dependence of the central authority on the Treasury is to be noted. While recognising that a Treasury guarantee cannot be had without the inevitable strings, here again it is hoped that general control will suffice, especially in view of the fact that, of all the industries which it is proposed to nationalise, the electrical industry is the most prosperous and involves the least financial risk to the Government.

The Bill further provides the central authority with rather tight control of the area boards.

* Abstracts from the Presidential Address, by J. S. Pickles, J.P., B.Sc., M.I.E.E., ; I.M.E.A. Convention, Bournemouth, June 20th to 27th.

Because the central authority is charged with the ultimate responsibility, this control is no doubt unavoidable, but it is hoped that area boards will be given the maximum amount of freedom of operation within a given policy. The area boards, subject to the general control of the central authority and the Minister, are left to reorganise the distribution side of the industry on lines to be determined by them, no indication being given in the Bill of the proposed arrangements below area level.

The area boards appear likely to be made up of a full-time chairman and possibly a full-time deputy chairman, the remaining members being part-time and presumably free from executive responsibilities, though each will no doubt take special interest in that side of the work where his particular experience lies. It is almost superfluous to say that the selection of the right men is of supreme importance.

The Area Consultative Councils are rather large bodies of twenty to thirty members, the success of which is viewed by some in the industry with doubt. Some channel by which the public can influence policy is vital, but there is at least a possibility that duplication or confusion with area boards' functions may creep in, and it would not be at all surprising if practice soon showed some alteration to be necessary in the composition or functions of these bodies.

In brief, the general impression of the new structure given by the Bill is of a rather tightly geared machine in which it seems imperative that flexible couplings should be introduced to ensure smooth running. This flexibility can and will be provided if full advantage is taken of the knowledge and experience available in the industry. In this connection the appointment to the Organising Committee of men of long and practical experience of the industry has given much satisfaction and reassurance.

The Change Over

When the Bill becomes an Act, what are the next steps that may be expected? Presumably the central authority and the area boards will be appointed without much delay, but they will require time in which to establish headquarters, to gather staff together, and generally put themselves in a position to control the industry effectively. Then the Minister will declare a vesting date on which existing authorised undertakers, whether company or municipal, will cease to exist. It is, however, inconceivable that any kaleidoscopic change can take place overnight in the daily routine of the industry. Continuity must be preserved and it is not unlikely that, with suitable control by the boards, existing organisations will be required to carry on as semi-independent units pending gradual, and to some extent evolutionary, formation of new district units by amalgamation. Such a process may well extend over a long period and it may be some years before the ultimate pattern is fully complete. During this transition period it is possible that local authorities as such, but no longer as electricity undertakers, may be required to act as agents of the boards for those functions in which it is impracticable to make a clear cut break immediately.

On the generation side, presumably the central authority will set up a technical body within the authority, not perhaps differing materially from the present technical organisation of the Central Electricity Board except in so far as may be necessary for power station staffs and relative management personnel to be taken over. The Bill appears to contemplate the ultimate separation of responsibility for generation and main transmission from that of distribution. Opinion varies as to the necessity or wisdom of this separation, it being argued by some that it would be more efficient for generating stations to be operated by the area boards, provision for which is also made in the Bill. An obvious possibility, however, is that the generation organisation may be based on the same areas as those of the area boards, possibly in the same headquarters, thus facilitating co-operation.

On the distribution side, it appears probable that the area boards will establish an executive staff at area level and will then decentralise by the formation of self-contained district units responsible for the day to day operation and routine in much the same way as the larger of the existing undertakings work to-day. Areas previously served by companies may in this respect be more readily dealt with than those of local authorities where the separation of closely knit staff, particularly on the commercial and legal side, and of joint arrangements of various kinds may well take time. The present higher executive staff will ultimately find their responsibilities enlarged in some aspects and restricted in others. At lower levels the staff will not feel the change so early and perhaps not to the same degree.

Some general standardisation of technical practice should be possible fairly quickly. Similarly, broad uniformity of general policy will be practicable within a comparatively short time, but elimination of many existing detailed variations may take an appreciable time.

While all this is proceeding, the industry cannot stand still or even pause. New generating plant extensions must not be delayed, new grid lines will be needed, consumers must be given the necessary day to day service, wages and working conditions may require adjustment and settlement, and in innumerable other ways continuity must be maintained. Obviously, most existing organisations, either in their present or suitably modified form, will be required to carry on until the new boards complete their plans.

I cannot pass from this forecast without a brief word as to the future of our own Association. It is obvious that the Association cannot possibly continue under its present constitution. Further, it would appear that any reconstitution would have to embrace all local authorities, since those that hitherto have not had an electricity undertaking will in future have a vital interest in the nationalised industry. Whether such an Association would be justified, or whether it is more practicable for existing local authority Associations to cater for these interests, is a matter for early consideration by the local authorities themselves.

The Spirit of the Industry

No industry, no matter how well organised, can be wholly successful unless it possesses the right spirit. This is an intangible but powerful factor, without which many a venture has failed or fallen short of expectations. It cannot be too strongly emphasised that unless the spirit which has created this industry is carried forward into the new organisation, then the rather hackneyed words of unification, co-ordination, and integration will be meaningless.

Fortunately, it is not a case of creating a new spirit but of maintaining that which already exists. This industry has always been a happy one. Among workers this is proved by the fact that serious labour troubles are practically unknown. Among staff at all levels the utmost good fellowship prevails. There are few departures to other industries or importations from outside.

Some of the reasons for this satisfactory state of affairs are:—

(*a*) The intrinsic interest of a profession based on a natural science.

(*b*) The uninterrupted expansion and prosperity of the industry.

(*c*) The excellent technical press.

(*d*) The stimulus of competition and rivalry.

(*e*) The reward of initiative and enterprise.

Believing that these are some of the very human considerations on which the success of all commercial organisations depends, I feel that they deserve the serious attention of the new authorities.

Continental Engineering News

The Eupen Dam

A large dam is at present under construction in Eupen, Belgium. Work was originally started in 1936. The dam is being built for the Belgian Ministry of Public Works in order to provide a reservoir, and thus increase the drinking water supply of the City of Liége and regulate the flow of the Vesdre River. It is hoped also that the supply of water made available will attract new industries to the district served. The dam is situated in the beautiful scenery of the Hertogenwald, and is a gravity structure. Its height above the bed of the river is 214ft and it will be 1475ft long. In plan the dam will lie on a curve having a radius of 1220ft. The thicknesses at the base and top are to be 170ft and 26ft respectively. The total volume of concrete to be placed is about 520,000 cubic yards, of which 470,000 cubic yards (90 per cent) are already placed. Before the war 3600 tons of building materials were used every day. A special railway line and yard were constructed for the purposes of the contractor. Owing to the war, works were considerably delayed and the dam will not now be completed before the end of 1948. The Eupen dam will retain about 33 million cubic yards of water.

Bridge Over the Tagus

A bridge over the Tagus is to be built at Vila Franca-de-Xira, about 19 miles from Lisbon, Portugal. The design approved by the Portuguese Government is a suspension bridge with a central span 850ft long and two side spans 425ft long each. The decking will accommodate a 29ft 6in roadway and two footpaths each 5ft wide. The architectural treatment of the bridge will be similar to the bridge over the Rhine between Cologne and Mülheim, built in 1929.

Public Works in Spain

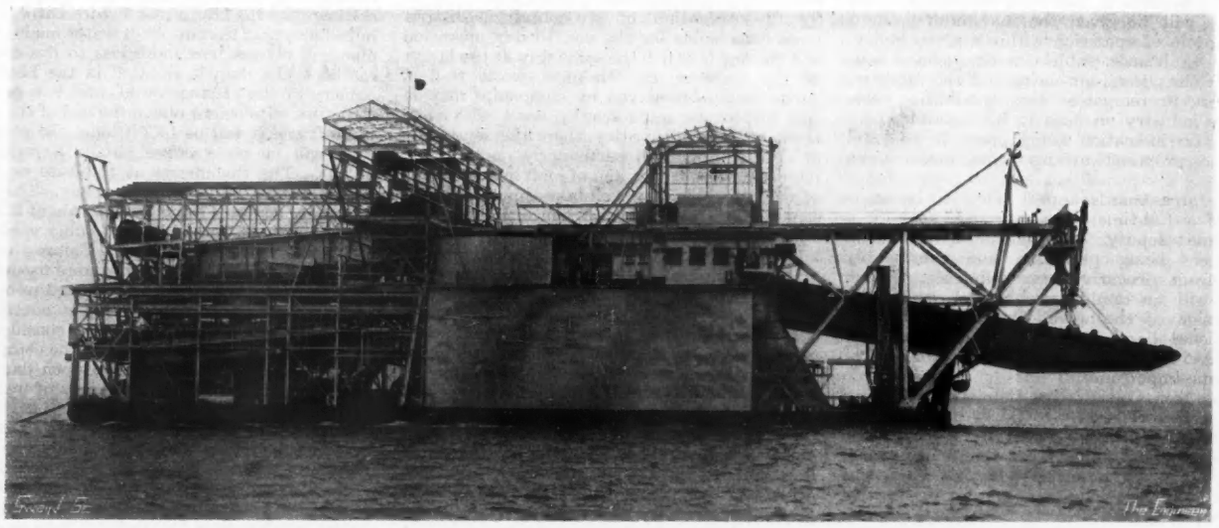
In an account recently published about public works carried out in Spain during the last ten years, Professor A. Pena Boeuf, former Minister of Public Works, refers to 1564 bridges built in that decade, including 89 long-span bridges. Amongst these structures are numbered the Esla viaduct, one of the four longest concrete arches in the world; a railway bridge of cellular construction with a span of 672ft and a rise of 192ft; the Tortosa bridge, a bow-string structure of the Langer type, with three spans of 180ft, 182ft 6in and 180ft; the Tordera bridge, an interesting example of composite steel and concrete construction, consisting of three spans of 148ft, 178ft and 148ft, each span carried by two fish-bellied trusses with concrete upper chord, while the lower chord and the diagonals are of electrically welded steel; the El Pedrido bridge, of the bow-string type; and the Amposta suspension bridge. Amongst hydro-electric works mentioned there are forty-three dams built or under construction. Since 1940, 400,000 acres of land have been irrigated. Other notable works mentioned include the Tardienta aqueduct, built of concrete, one of the largest aqueducts in Europe, with a discharge of 2500 cubic feet per second, and the new horse-race stadium in Madrid, comprising a reinforced concrete grandstand of an original design, due to Professor Ed. Torroja.

Swiss Railway Centenary

The first Swiss railway line, 14½ miles long, linking Zurich with Baden, was opened on August 7, 1847. This year therefore Swiss railways are celebrating their centenary.

The present length of Swiss railway lines is 3700 miles, of which 78·7 per cent are electrified. Of this figure, 1800 miles, *i.e.*, nearly 50 per cent, are operated by the Swiss Federal Railways. The Federal Railways possess at present 546 electric locomotives, 333 steam locomotives, 159 mountain locomotives, 3426 passenger cars and 18,691 goods wagons. In addition, there is a small amount of rolling stock for narrow-track lines (47 miles). Besides the Federal Railways there are some private railway companies, such as Rhätische Bahn (narrow-gauge, 880 miles of lines); the Bern-Lötschberg-Simplon railway (normal gauge, 75 miles of lines); &c. Rivers and mountain ravines are spanned by 4939 bridges, of which 1291 have a length exceeding 33ft. The total length of Swiss railway bridges amounts to 250,000ft. There are many tunnels, 150 of which have a length of 1000ft and more.

TIN DREDGER FOR THE EAST INDIES



DREDGER "ROOSEVELT" RIGGED FOR TOWING

Large American - Built Tin Dredgers

TWO of the largest tin mining placer dredgers ever constructed in the United States have been designed by the Bucyrus-Erie Company, of South Milwaukee, Wis., to the order of the Mining Equipment Corporation, of New York, a subsidiary of the Billiton Company, of The Hague, Holland. These dredgers are to be operated in the East Indies, and we are indebted to the Bucyrus-Erie Company for the following details and the illustrations of the new equipment.

The special dredging machinery was built by the Bucyrus-Erie Company and the Tampa Shipbuilding Company, of Tampa, Florida, was selected as sub-contractor to prepare shipyard working drawings and build the hull, superstructure and housing. This company also assembled and installed the dredging machinery and equipment under the general guidance of the main contractors.

The first dredger was launched on October 28, 1946, and was named the "Stuyvesant." The second, the "Roosevelt," was launched on January 6, 1947, and the photograph we reproduce above shows the vessel at the outset of the voyage to the Dutch East Indies on May 9, 1947.

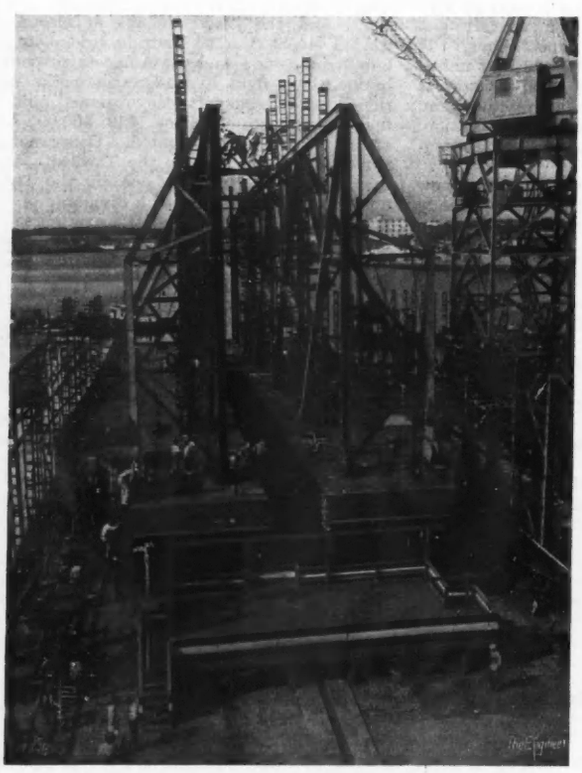
The two dredgers are identical in design and have been built to excavate tin-bearing sand and gravel to a maximum depth of 100ft below water level. Each hull is 246ft long, 76ft wide and 12ft 6in deep, the estimated working displacement being 4150 tons. The total length over the gangway bridge at the bow and the tailing sluices at the stern is 476ft. A pilot house is situated 36ft above deck level, whilst the highest point of the dredger is some 85ft above water level.

The fabricated steel hull is divided into fifty-two compartments by two longitudinal watertight bulkheads and twelve main transverse bulkheads, the ladder well and miscellaneous tank bulkheads. Four longitudinal trusses extend the full length of the hull, which has transverse frames spaced 2ft apart, except at the extreme stern, where longitudinal framing has been adopted. The hull is further strengthened by a pair of main trusses set 9ft off centre port and starboard. The upper chord of these trusses is 50ft above the main deck and has diagonal and lateral bracing. At the forward end of the hull is a well or slot 8ft wide and 140ft long to accommodate the digging ladder. This well extends the full depth of the hull and divides the vessel into two separate structures for more than half of its length.

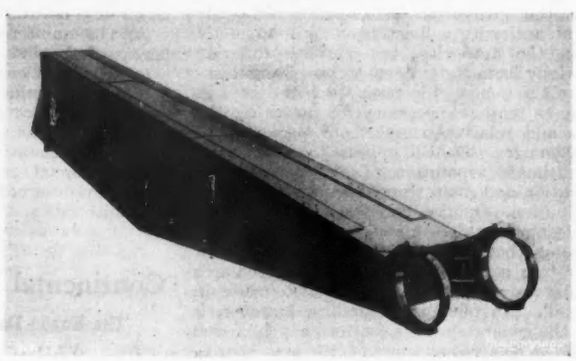
Digging Machinery and Working Plant

The digging ladder is 216ft long and weighs 220 tons without its equipment; with the buckets, rollers, idlers, tumblers, &c., it weighs some 650 tons. This ladder, which is 8ft wide and 13ft deep, carries an endless chain of 148 manganese steel buckets. Each bucket weighs, with its pin, 4025 lb and has a capacity of 14 cubic feet.

The upper or inboard end of the ladder is pivoted on a trunnion 57ft above the water line. Buckets are actuated by an upper tumbler, the driving machinery of which is powered by a d.c. motor with Ward-Leonard control. Idler rollers spaced along the ladder support the bucket chain. The ladder is suspended by two tackles from a heavy bow gantry extending 30ft beyond the forward end of the hull. This suspension tackle is operated by another d.c. motor, with similar control gear, geared to a quadruple drum winch situated on the top chord of the main truss. With this tackle the



PRE-LAUNCHING VIEW OF THE "STUYVESANT"



UPPER END SECTION OF THE 216 FT. DIGGING LADDER

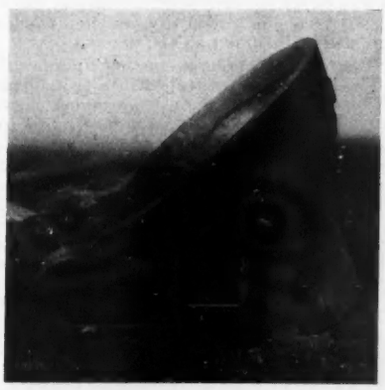
outer end of the ladder can be raised or lowered in an arc to dig material to the maximum depth of 100ft below water level.

Material raised by the buckets is discharged into a revolving screen, 10ft diameter, 70ft long and weighing 90 tons. Tin-bearing concentrates from the screen first pass over twenty-four four-cell primary jigs, after which additional jigs further refine the concentrate through second and third stages. The concentrates finally produced are then loaded on to barges for shipment to refineries. There are 128 cells in all in the jig washing plant.

Waste material or tailings are discharged 150ft astern of the dredger at a height of 6ft above water level, through chutes from the main jigs. When barren overburden is being dug a removable chute is placed in the revolving screen and the material passes along this chute to by-pass the treatment plant. From the chute the material passes into a central sluice, which discharges it 120ft astern.

At points where excessive wear is likely to occur the hoppers and chutes are lined with abrasion-resisting steel plates, and the distributor and disposal sluices are lined with a special rubber composition which is vulcanised to the plates.

Some 1¼ million gallons of water an hour are required to wash and sluice the tin-bearing



14 Cub. Ft. Bucket

sands, and six 12in and one 5in pumps are installed to supply this water.

Control and Power Equipment

Whilst it is working a dredger is manœuvred by means of six lines—two bow swing lines, one head line, two stern lines and one tail line. These lines are handled by six independent winches, each of which is driven by a d.c. motor with Ward-Leonard variable-voltage control. All of the equipment for the variety of dredging and other operations is controlled by electric and hydraulic means, and practically all of it is automatic. The lay-out of this equipment is such that the operator's principal job is restricted to handling the controls of the various motors with the minimum manual effort.

Power for the large number of motors on a dredger is supplied by three diesel engine driven generator sets, one of which serves as a standby. The diesel engines are of the vertical, four-cycle, trunk piston, solid-injection type, each having eight 13in by 16in cylinders. These engines are supercharged and each develops 875 h.p. at 375 r.p.m. Each engine is coupled to a 600-kW, three-phase, 50-cycle, 400-V generator. Whilst overburden is being dug one generating set is sufficient to supply the full power requirements of a dredger. Two 75-kW diesel generator sets are also installed for emergency standby and auxiliary service.

The safety equipment installed is particularly comprehensive and includes a bilge alarm system for each water-tight compartment, a freeboard alarm at each corner of the dredger, a depth indicator and a revolution counter. Other devices for indicating and recording the performance of all major units include a gauge panel on which is indicated the operating conditions of all units in the tin concentrating plant.

The preparation of the dredgers for their launching at Tampa and towing to the East Indies involved a fairly considerable amount of work and is of some interest. We reproduce a photograph which was taken prior to the launching of the "Stuyvesant,". The hull and main truss were substantially complete at the time, giving a launching weight of 1150 tons, including 135 tons of water ballast in the after compartments.

Heavy plate brackets were installed temporarily in the ladder well to tie the port and starboard sides of the hull together. Careful alignment of the hull and the launching ways was necessary owing to the breadth of the hull, which left a clearance of only 2ft on each side. After launching, the superstructure was built and the machinery installed at an outfitting pier.

In preparation for the voyage to Banka, the digging ladder was secured in position well above the water line, with all buckets removed and stowed aboard the dredger. The main deck houses enclosing the engine-room and machine shop were provided with water-tight doors and plate closures set over all windows and other openings. Plating which would offer undesirable surfaces to storm winds was removed from the sides and roof of the treatment house and from the upper houses enclosing the ladder hoist machinery. The pilot house was fitted with temporary galley and living quarters for the eight men forming the towing crew, and necessary safety equipment, such as lifeboats and rafts, was installed. Exposed motors, chutes, sluices and various items of the treatment plant were stowed and secured within the machine shop. Canvas covers were provided for exposed motors which could not be stowed. All cranes and hoists were securely chocked to prevent any motion, and a V-shaped bulwark, 10ft high, was built across the after end of the main deck, and heavy temporary shoring installed in the scow-shaped after compartments to resist the battering of heavy seas which might be encountered, as the dredger is being towed stern first, with the bow or ladder end trailing.

The towing bridle consists of a 2¼in stud link chain attached to a 2in cable leading to the towing winch on the tug. The tow is being made with approximately 1800ft to 3000ft of cable out, depending upon weather conditions.

The 13,000 miles towing operation involved in delivering the dredgers to the East Indies is the longest international tow to be made under the flag of the United States. For this purpose big diesel-engined ocean-going tugs built during the war have been chartered from the U.S. Maritime Commission. The trip is being made *vid* the Panama Canal and is estimated at three months with one stop at Pago Pago, in American Samoa, for refuelling.

Reconstruction of the Italian State Railways

Recently we received from the Italian State Railways some particulars of the damage they sustained during the war and of the efforts to restore normal working since the end of the war. We reprint below extracts from the statement.

The recent conflict covered our whole country and engaged all the resources of the opposing forces. Therefore the ways of communication were the object of systematic destructive action by every means available. Indeed, as the war raged on the whole Italian peninsula, with incessant and massive air attacks and bitter land fighting, it caused terrific damage and devastation to the network of the Italian State Railways. Apart from this, there was methodical destruction by the German invaders as they retreated.

The Damage Sustained

It is impossible to describe in this brief document the particular damage which took place, but the huge extent of the disaster to Italian transport can be gauged by the following broad details. At the end of hostilities, destroyed or damaged works were as under:—

4500 km of line tracks (21 per cent of pre-war total).

2600km of station tracks (35 per cent).

68km of masonry bridges (28 per cent).

35km of steel bridges (45 per cent).

64km of tunnels (7 per cent).

10,000 various buildings (36 per cent).

3850km of high tension electric lines (65 per cent).

8200km of overhead electric wires (69 per cent) and about 40 per cent of signalling installations.

In addition, the following rolling stock was either destroyed, heavily damaged or removed:—about 2300 steam locomotives (59 per cent); more than 1000 electric locomotives (78 per cent); 170 electric railcars and electric trains (80 per cent); 770 motor railcars (96 per cent); 9900 carriages, luggage vans and mail vans (81 per cent); about 100,000 freight wagons (73 per cent).

This great destruction of plant and material was accompanied by almost intolerable conditions for the employees. These people, who fully accomplished their duties in spite of dangers and discomfort, found themselves without houses and clothes, in a state of semi starvation, and severely shaken by the losses of both relatives and personal possessions. But, none the less, they knew that the reconstruction of the Nation was chiefly based on the reconstruction of the railways and that until this became possible there would be no prospect of a return to normal conditions of life. This realisation aroused their fullest energies, so that the task of reconstruction was conceived and undertaken with firm determination. In this way, in little more than a year, quick and definite successes have been achieved beyond all hopes and expectations.

Work of Reconstruction

It is true that the Allied Armed Forces, with all their wealth of mechanical equipment, helped the resumption of traffic on some lines, but in most cases their work was limited to provisional reconstruction to meet the essential military needs, and therefore useless for any permanent plan, and sometimes even harmful to long-term reconstruction.

Thus, the huge load of reconstruction weighed almost entirely on the exhausted resources of our country, which has received only scanty help in industrial products from some of the United Nations. Nevertheless, notwithstanding the difficult conditions of our industries, lacking as they do raw materials, fuel and electric power, the work which has already been carried out is imposing.

We adopted the following priorities for our work: top priority for the rehabilitation of plant, the re-establishment of main lines in the shortest possible time; the employment of the maximum amount of labour with the minimum use of materials; the widest possible use of remnants and scrap material. By this means we have already rehabilitated the following: 50 per cent of destroyed or damaged line tracks; 50 per cent of station tracks; 42 per cent of masonry bridges; 20 per cent of steel bridges; 33 per cent of tunnels; 54 per cent of buildings; 48 per cent of high tension lines; 55 per cent of overhead electric wires, and 20 per cent of signalling.

Concerning rolling stock, the following data are of interest: some new electric locomotives class "E 424" and new light carriages are already in service; 7140 new goods wagons have been built; 14,000 heavily damaged wagons have been reconstructed. As the result of new construction and repairs, the rolling stock in use has been improved in the following ranges: steam locomotives, from 2000 to 2250; electric locomotives from 740 to more than 1000; electric railcars and electric block trains from 65 to 105; motor railcars from 126 to 180; goods wagons from 67,000 to 87,000 (in the latter figures, however, are included foreign wagons still circulating on the Italian network).

Other significant indications of the range of reconstruction are the figures for passenger-kilometres and ton-kilometres. These figures show that during the current period we have reached a passenger traffic higher, and a goods traffic not much lower than those of pre-war periods. Even the speeds of trains, after a necessarily slow restart, are rapidly nearing pre-war rates.

The results which we have described are only those of the first stage. It is, however, hoped that during the year 1949 the reconstruction of tracks, stations and buildings will be completed, and that it will, in fact, be already very advanced at the end of 1948. We may add the estimate that during the year 1947 doubling of tracks on the lines Milan-Florence-Rome-Naples-Battipaglia, on the line Modane-Turin-Genoa-Rome and on the line Turin-Milan will be completed. If we are able to carry out in full our programme of rehabilitation and new construction, at the end of 1950 our rolling stock will be, in its most up-to-date forms, better than in 1940.

As a whole, if the necessary raw materials come in time from abroad, if the financial means are available, and if Italian industries are able to maintain production, the Italian State Railway system will have regained its pre-war efficiency before the beginning of the Holy Year 1950, and will be ready to serve the exceptional traffic for that occasion.

When reconstruction is finished, the railway system will show itself improved from all points of view. The laying of tracks is being improved wherever possible without excessive expenditure; new types of track and switches have been adopted; the steel and masonry bridges are being more strongly built; the four-aspect signalling system is being adopted; the automatic bloc system is being extended and automatic repetition of line signals in locomotives will be adopted. The network of electrified lines will be greatly extended, because the change-over programme which has already been resumed, includes amongst others, the following lines at present worked by steam: Turin-Venice; Bologna-Padua, Voghera-Piacenza, Ancona-Bari, Messina-Palermo, Messina-Siracusa.

Concerning rolling stock, we may mention the projected construction of electric trains each composed of seven units, and the lightening of carriage bodies and improvements in the structure and internal adjustments of carriages in order to achieve a greater comfort for passengers. Continuous brakes and lightened axles and roller bearings will be adopted on goods trains, too, in order to effect the speedy transport of early fruits and vegetables and other commodities.

Plural Starting of Electric Motors

MANY mechanical drives involve the continuous running of a number of electric motors for long periods during which the starters remain idle. This kind of duty is commonly encountered, for example, in paper mills, and in continuous chemical processes, as well as in ships, where many of the engine-room auxiliaries are normally required to be started up not more than once per voyage. If there are several motors in the engine-room, the use of individual starters makes heavy demands on the available deck space.

In an effort to solve the problem of starting a number of motors economically, making the best use of restricted space, the General Electric Company, Ltd., Magnet House, Kingsway, London, W.C.2, some years ago evolved a "plural starter" system. Plural starting is an arrangement whereby a single common starter performs the duties that normally require a separate starter for each of a large number of motors. Provided that the number of motors to be controlled is sufficient to warrant its use, this method of plural starting not only saves space but reduces the prime cost and installation charges incidental to the provision of a separate starter for each of a group of motors. Moreover, fewer spare parts are required and in marine applications the amount of switchgear called for under classification rules is reduced.

The number of motors controlled by the plural starter varies with the requirements of each installation. For example, the 10,000-ton M.V. "Somerset," of the Federal Steam Navigation Line, uses a single plural starter to start up eleven motors varying from 8 h.p. to 40 h.p., whereas in a new passenger vessel now under construction there will be two starter equipments covering a total of twenty-four motors, ranging from 15 h.p. to 155 h.p. Recent improvements have resulted in considerable simplification of the system and also in an extension of the range of motor sizes which can be controlled in this way. Plural control for ships' motors at 220V is now particularly economical for a range of machines from 15 h.p. to 150 h.p., but the equipment can be made in larger sizes from 100 h.p. to 350 h.p. for industrial installations. Although the system is primarily designed for starting d.c. motors, it can in many cases be employed with a.c. motors, unless they are arranged for star-delta starting.

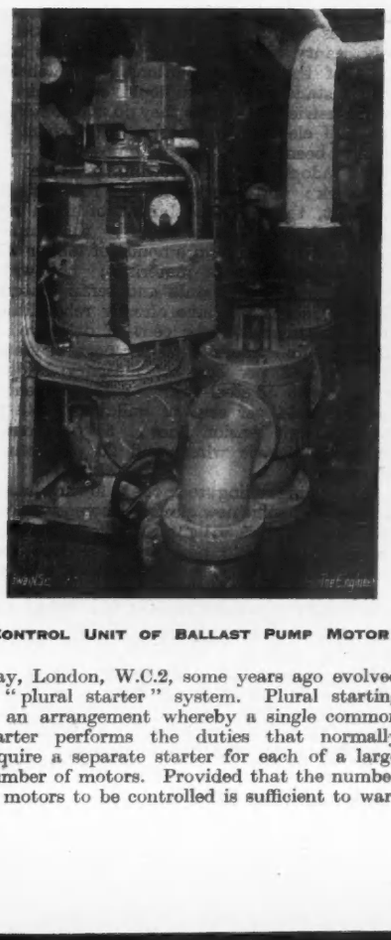
The following description is based on the plural starting installation in the engine-room of the M.V. "Somerset," which provides a typical example of the system in its improved form. The equipment comprises a motor control unit on each motor, an open type contactor panel for each motor and a common, or plural, starter for all the motors.

Each motor control unit is contained in a small steel case mounted directly on the motor in the place usually occupied by the terminal box, which is not required. Our first illustration shows the control unit fitted to 30/58 h.p. motor driving one of the ballast pumps in the M.V. "Somerset." The control unit contains the "start" and "stop" push buttons, indicating lamp and isolating links. Where required, a shunt regulator and an ammeter can also be mounted on the unit.

The rest of the plural starting equipment in this installation is embodied in a switchboard, which, as shown in the accompanying engraving, consists of eleven contactor panels (one for each motor) and a common or plural starter panel. Each contactor panel mounts line and starting contactors (one line contactor and one fuse for motors up to 20 h.p., a double-pole line contactor for machines over 20 h.p.), also a meter test link, an overload relay and a switch, or link, for isolating each individual panel, together with the associated motor and interconnecting cable.

In the switchboard illustrated herewith the plural starter is mounted in the central panel of the three right-hand panels.

The plural starter consists of the starting resistance and a motor-driven drum con-



CONTROL UNIT OF BALLAST PUMP MOTOR

PLURAL STARTER SWITCHBOARD

trolled by a pilot contactor. The drum has two driving motors, mounted at the back of the board, with a selector clutch so that either motor can be used. Alternatively, two complete common starters can be supplied, with a selector switch, one starter being a standby. The simplified arrangement of one drum and one resistance has been approved by the Classification Societies. The drum motor has two field windings, one connected across the armature and the other across the main starting resistance. When a small motor or a motor starting against light torque is started up, the voltage drop across the resistance is small. Thus the field of this separately excited winding is weak and the drum motor runs at, or near, its maximum speed. When, however, the motor being started is large or is to be started against a heavy torque, there is a considerable voltage drop across the resistance, resulting in a strengthening of the separately excited field, so that the drum motor runs at reduced speed, and the machine is accordingly started up more slowly.

Interlocks are provided to prevent the starter being connected to more than one motor at a time, and an overload relay for each motor gives full protection during both starting and running. For marine installations provision is also made on each panel for tripping from a "non-essential" tripping circuit, when this facility is desired.

Operation of the starter is initiated by pressing the "start" button, whereupon the starting and negative line contactors close and auxiliary contacts on these contactors start up the drum motor by means of the pilot contactor. As the drum revolves, the resistance steps are cut out until the drum has made one revolution, by which time the motor driven auxiliary is up to speed. The positive line contactor closes and the starting contactor opens, so that the motor is connected direct to line and the common starter is disconnected and is ready to start up another motor. When large motors have to be started the drum type starter is augmented by contactors or replaced by contactor starter operating under time control. Operation is similar to that of the drum type starter, the positive line contactor closing after the action of the last starting contactor.

In addition to those applications already mentioned, many others will suggest themselves. In particular, a promising field is provided by those industrial processes where a number of motors must be started in a predetermined sequence, such as in conveyor and material-handling installations.

Infra-red Heating by Gas

THE Infra Red Heating by Gas Exhibition, organised by the British Gas Council at Gas Industry House, 1, Grosvenor Place, Hyde Park Corner, London, S.W.1, which was officially opened on Thursday, June 19th, will remain open until the end of July. At the opening ceremony Mr. William Leonard, Joint Parliamentary Secretary of the Ministry of Supply, who was introduced by Colonel H. C. Smith, the Chairman of the British Gas Council, said that this new use of radiant heat was of tremendous importance to industry, since it saved time and coal, and widened many industrial bottlenecks. Thus drying metal finish on bedstead frames now took 8 min. instead of 600 min. previously. Agricultural machinery, which was so badly needed, took 6 min. to dry, whereas previously it required an hour. Other important applications of radiant heat were the drying of ceramics and the working of plastics. The British gas industry deserved, he said, the greatest credit for this new development.

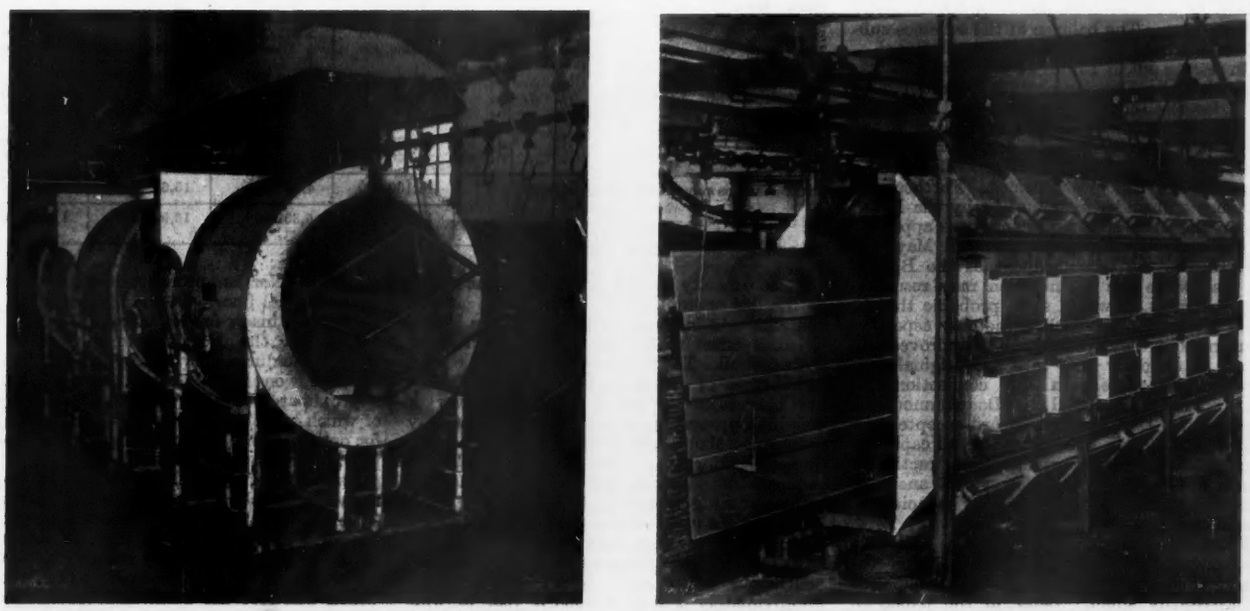
The exhibits show various articles dried and treated by radiant heating methods, and for those who cannot visit the exhibition information can be supplied at industrial gas centres throughout the country.

The accompanying engravings illustrate the two principal types of dryers, the black emitter tunnel and the flat panel type of dryer, both of which are on view, with the travelling conveyor for transporting the components. Examples are also displayed of the high-temperature incandescent type of dryer. The preparatory and development work on the black emitter burners was carried out in the research department of the Gas Light and Coke Company, and it has now been applied to a variety of industrial processes and is manufactured by different firms. In principle, dull metal plates are heated by gas burners and the plates radiate heat. The medium temperature range is from 450 deg. to 650 deg. Fah., but higher maximum temperatures, up to, say, 900 deg. Fah., can be attained. The high temperature range is from 1100 deg. to 1800 deg. Fah., but for almost all normal drying and, in particular, metal finishing processes, temperatures up to 650 deg. Fah. are adequate.

In the left-hand view we show an infra-red tunnel made by Neil and Spencer, Ltd., which is drying cycle frames at the works of Sterling Electric Holdings, Ltd., Dagenham. In this design of plant there is a row of gas burners, firing into a chamber bounded on the outside by insulation and on the inner side by a black panel of mild steel. An inner sheet or baffle plate is attached to the lower half of the radiating panel in order to protect the panel and to provide even heat distribution. The units are generally constructed in semi-cylindrical sections, 3ft and 4ft long, and of diameters 2ft, 3ft and 4ft, which may be joined together to form any desired tunnel length. A conveyor travels through the tunnel for transporting the components to be dried. The hoods above the tunnel for removing the burnt gas products may be noted.

Another pattern of heater is that with flat panels, which we illustrate in the right-hand view reproduced below. It was made by Thomas Potterton (Heating Engineers), Ltd., and is shown drying steel house components at the works of Steel Fabricators, Ltd., of Cardiff. The panels are arranged horizontally or vertically, and may be inclined to suit differing shapes of components. The same principle is adopted as in the previous design and the hot gases from the burner flow between a black radiating panel and an insulated back.

At the exhibition provision is made to demonstrate both these types of radiant heaters.



INFRA-RED PAINT DRYING TUNNELS

UNITED KINGDOM REGISTERED SHIPS.—The Minister of Transport wishes to draw the attention of all owners, managers and masters of, and other persons interested in, British ships to the fact that the Control of Trade by Sea (No. 2) Order, 1939, made under Regulation 46 of the Defence (General) Regulations, 1939, applies to all British ships, except fishing boats and Government ships, registered in the United Kingdom, the Channel Islands or the Isle of Man, and having a gross tonnage of 100 tons or more. It is pointed out that the procedure under the Order must be complied with, irrespective of the nature of the voyage contemplated and whether cargo is carried or not. The Order provides that no ship of 100 tons gross or over shall proceed to sea from any port on any overseas voyage except under authority of a licence granted by the Minister or by the Ship Licensing Committee (Overseas Voyages). Applications for licences for overseas voyages should be made to the Secretary, Ship Licensing Committee (Overseas Voyages), Ministry of Transport, Berkeley Square House, London, W.1.

The Iron and Steel Development Plan — Some Statistical Considerations*

By R. M. SHONE

No. II—(*Continued from page 541, June 20th*)

Progress of the Development Plan

The original Plan envisaged a total expenditure of £168 million at 1945 prices. The schemes involved were to be started over a five-year period and completed in seven and a half years. So far schemes totalling £140 million have been worked out in detail by the industry and have been submitted to the Board for final approval. Approval in detail has been given to schemes totalling approximately £90 million, and on these it has been possible to make a start and they are in varying stages of progress at the present time. Certain further schemes have been generally approved by the Board, but there are still problems connected, for example, with housing, &c., which are preventing a definite start being made. With these the total passed by the Board amounts to approximately £125 million. The balance of the schemes submitted are under consideration by the Board.

In setting out in Tables IV to VI the position regarding the Development Plan, the figures both for the schemes approved and for those at present under consideration by the Board have been grouped together to show the progress made in translating the general Plan into detailed and concrete schemes. Further, the schemes still under examination by the Board are in the main schemes which were approved in principle by the Government in May last year before the establishment of the Board; so that while the examination may result in some changes, it would seem probable that in their general lines, which is the only aspect of concern here, they are likely to be approved and to fit at an early date into the original construction schedule. In this connection the Chairman of the Iron and Steel Board announced on April 28, 1947, that the Board accepted the aim of the Plan in relation to overall capacity, considered that it represented the practicable maximum over the next few years, and also accepted the broad distribution of capacity set out in the Plan.

Since most of the major schemes will take approximately three years to complete, the amount of new construction already completed is necessarily small. Later in the paper an indication will be given of the extent to which the building at present going on will result in new capacity coming into use at an early date.

In estimating the extent to which the Plan has been submitted in detailed form for execution, the figure of the total expenditure on the schemes submitted of £140 million in relation to the original estimated cost of the Plan as a whole of £168 million tends rather to overstate the position. This would indicate that about 80 per cent of the Plan has been put forward. Tables IV, V and VI, however, which relate to the progress in physical terms, show that about 58 per cent of the blast-furnace building, 80 per cent of the steel furnaces and 66 per cent of the rolling mill developments, taken as a whole, have been submitted to the Board. Thus, about two-thirds of the capacity to be built under the Plan has been put forward in definite schemes.

While the total new building submitted represents about two-thirds of the total building under the Plan, the increase in capacity resulting from the plans already submitted amounts to 86 per cent of the total increase envisaged in the case of steel furnaces and 87 per cent in the case of blast-furnaces, as will be seen from Tables IV and V. The increase in capacity more closely corresponds to the ultimate increase because the more urgent schemes are in general aimed at expansion as well as increasing efficiency. Also, since the schemes are associated with a large scrapping of existing plant, much of which has still a useful life of a number of years, it will be possible, given flexibility in raw material supplies, to retain for a period some of this plant to achieve a high level of production pending the full completion of the Plan. Even when it is complete, if a capacity of 16 million tons is inadequate, there would be the possibility of retaining for a time some part of the capacity of 4 million tons which it is ultimately proposed to scrap and so permit an element of elasticity—given a corresponding elasticity of raw material supplies—in meeting requirements if they diverge materially from estimated requirements.

Steel Furnaces.—Turning now to the position in more detail, Table IV shows that on the steel furnace side new building totalling 4,148,000 tons has been submitted for approval, as against the total in the original Plan of 5,835,000 tons.

In addition, arrangements have been made to convert approximately one-third of the steel furnace capacity at present using producer coal to the use of liquid fuel. This will in general contribute to increased output from the plants as some offset to the increased cost of firing with fuel oil. The main use of coal in the steel industry is, of course, in the form of coke for the blast-furnaces, but the changing over of this high proportion of steel furnace plant may save up to about 1,800,000 tons of coal a year, or approaching 10 per cent of the overall coal required in pig iron, steel furnaces and the primary rolling processes.

Among the main schemes already approved is the new steelworks at Margam, in South Wales, with steel furnaces designed to supply the new continuous strip mill, which will produce approximately 1 million tons a year of wide coiled strip as a basis for further continuous cold rolling into tinplate and sheet. Site preparation work has already started here and the first new blast-furnace in connection with this plant came into operation at the end of 1946.

The scheme for a new steelworks at Dorman-Longs on the North-East Coast has also been approved. This plant incorporates a universal beam mill to produce broad-flange beams, which will effect important economies in the weight of steel involved in structural work.

In Lincolnshire, extensions to the steel melting shop at Lysaghts have been approved, together with the scheme for the laying down of a modern continuous billet mill producing 450,000 tons of billets a year. Considerable progress has already been made, both on the steel furnace and blast-furnace side, in expanding production in preparation for the installation of the new mill. A new melting shop at the Appleby-Frodingham works has been approved and construction is well advanced so that it should come into operation by the end of 1947. The modernisation of the heavy section mills at these same works is also proceeding.

The rebuilding and enlarging of the Round Oak Works, based essentially on the scrap arising in the Birmingham area, has already been started.

A scheme is under consideration by the Board for the rebuilding and enlarging of the steelworks, associated with the Summers continuous strip mill for sheet production at Shotton.

The proposed expansion of steel furnace capacity in Northamptonshire has been approved in its general lines. In the original Plan provision was made for an increase in steel production in the Northamptonshire area, the essential features of which were that it should be based on home ores and would provide approximately 500,000 tons of billets per year, of which two-thirds would initially be available for outside sale. A detailed examination of the possibilities showed that the most rapid progress in reaching the objective would be by an extension on the site of the Corby Works. A scheme has therefore been worked out by Stewarts and Lloyds involving the expansion of production at Corby by rather over 700,000 tons of steel, mainly basic Bessemer quality, which will give the additional billets required for sale and also provide a basis for the expansion of tube production made particularly urgent by the growing export demands. A problem still to be finally resolved in connection with this scheme is the provision of additional houses for the labour expansion required.

The areas in which major schemes have still to be submitted are for the further rebuilding of steel plant in the North-East Coast area as a basis for continuous billet production, and the extension of blast-furnace and steel furnace capacity in Scotland. In both these cases schemes have not the same urgency as certain of the other districts. Production of billets on the North-East Coast is already carried out in specialised plant giving many of the benefits of large-scale production. In Scotland the

Table IV.—*Steel Ingot Capacity. New Schemes Already Submitted*
(Tons)

	Present capacity.	New building.	Future capacity.	Increase in capacity.
South Wales	3,000,000	850,000	3,250,000	250,000
North-East Coast	3,050,000	612,500	3,250,000	200,000
Scotland	2,000,000	235,000	2,115,000	115,000
North-West Coast	360,000	—	250,000	110,000
Sheffield	2,100,000	13,500	2,100,000	—
Lancashire, Flint, &c.	1,000,000	700,000	1,175,000	175,000
Staffordshire	700,000	250,000	650,000	50,000
Lincolnshire	1,350,000	745,000	1,620,000	270,000
Northants	540,000	742,000	1,282,000	742,000
Total schemes submitted by the industry	14,100,000	4,148,000	15,692,000	1,592,000
Total original plan	14,100,000	5,835,000	15,950,000	1,850,000

Table V.—*Blast-Furnace Capacity, Basic and Hematite.—New Schemes Already Submitted*
(Tons)

	Present capacity.	New building.	Future capacity.	Increase in capacity.
South Wales	1,200,000	600,000	1,600,000	400,000
North-East Coast	2,200,000	400,000	2,332,000	132,000
Scotland	650,000	225,000	700,000	50,000
North-West Coast	650,000	—	650,000	—
Sheffield	150,000	—	150,000	—
Lancashire, Flint, &c.	250,000	100,000	350,000	100,000
Staffordshire, &c.	400,000	—	400,000	—
Lincolnshire	1,200,000	600,000	1,400,000	200,000
Northants	620,000	850,000	1,280,000	660,000
Total schemes submitted by the industry	7,320,000	2,775,000	8,862,000	1,542,000
Total, original plan	7,320,000	4,750,000	9,100,000	1,780,000

* Royal Statistical Society, May. Abstract.

problem of replacement of a large proportion of obsolete plant does not arise, nor is it one of the areas, mainly those based on home ore, on which the main expansion of production was designed to take place.

Blast-Furnaces.—Table V shows that in the case of blast-furnaces the schemes submitted provide for 2,775,000 tons of new building, compared with 4,750,000 tons in the original Plan.

Schemes approved include the extensions in South Wales in connection with the new South Wales Steelworks, the building of enlarged new furnaces at Lysaghts in Lincolnshire and the addition of two new large blast-furnaces at the Appleby-Frodingham works of the United Steel Companies to replace smaller units. These will be added to the two large modern furnaces completed at Appleby in 1939 and provide a four-furnace unit. A third furnace has been approved at Consett, on the North-East Coast, which will be additional to the first modern furnace completed in 1942 and the second furnace, which is expected to come into operation during the course of 1947. A third furnace is also being built at the Clyde Ironworks in Scotland, which will enlarge the two-furnace plant completed at the beginning of the war. Blast-furnace developments at Corby are associated with the new steelworks extensions.

The main schemes still to be submitted are those for the expansion of pig iron production in Scotland and for the building of blast-furnaces at the Shotton Works to replace and increase the supplies at present drawn from the Midland area. A major modernisation of the blast-furnaces on the North-East Coast was also envisaged in the original Plan. Approval has already been given to the scheme for modernising the ore unloading and handling facilities in this area. This is proceeding at the present time and the further plans for the replacement and rebuilding of blast-furnaces on the North-East Coast are expected to come forward shortly.

Rolling Mills.—Table VI shows the extent to which schemes have been put forward on the rolling mill side.

In the case of billet mills, two schemes for development on home ore fields, in Lincolnshire and Northamptonshire, have been approved. It was always envisaged that development of billet production should first take place on home ore sites.

A scheme for the building of a new four-high plate mill, together with the concentration of the production at the Consett Works on plates, has been submitted, but not yet approved, for immediate construction.

Proposals covering the main developments in the heavier section mills are well advanced. Modernisation at the Appleby-Frodingham works in Lincolnshire is proceeding. Modernisation of the mills at the Round Oak Company, Birmingham, on medium sections is already under way. The scheme for the broad-flange beam mill on the North-East Coast, which is much the most important scheme in connection with the modernisation of the production of heavy structural material, has also been approved.

In the case of sheet and tinplates, the developments already referred to both in South Wales and Shotton have been approved. In the lighter mills, schemes have been approved for a new bar and rod mill integrated with the continuous billet mill in Lincolnshire and for further strip production at Corby. A rod mill at the works of Richard Johnson and Nephew has been approved and construction is already well advanced. The new window section mill at Darlington is coming into full operation. The plans for a new rod mill at the Lancashire Steel Corporation have been submitted. Schemes have also been approved for developments in other finishing sections of the industry, for example, in tubes, tyres and wheels, wire and stainless steel.

Taken overall, the rolling mill schemes already submitted would enable most of the production target figures to be reached, as in almost all cases the new building proposed is considerably greater than the net increase in production envisaged. There is in most instances a substantial reserve of existing capacity, some of which can be retained pending the completion of the balance of the Plan.

Timing of Construction.—The timing of construction has generally followed the line of priorities suggested as desirable in the original Plan. Priority has been given to a number of urgent schemes for developing output at existing plants where quick benefits would result. Indeed, some of the early benefits from the Plan will be realised during this year from new blast-furnace capacity in South Wales, on the North-East Coast, in Lincolnshire and Scotland, from the steel furnace oil conversion programme and from new steel furnaces, particularly at the melting shop at the Appleby works in Lincolnshire.

Among the major schemes, first priority was indicated as desirable for the new South Wales steelworks and strip mill for the production of sheets and tinplate. The second major scheme which was indicated as particularly urgent was the new broad-flange beam mill on the North-East Coast, designed not only to give a highly efficient production of heavy structural material, but also to provide an important new type of product for the export trade. Of the new continuous billet mills which, it was considered, should be proceeded with urgently, the first was that at the Lysaght plant, and this has already been approved and constructional work on the early stages of the scheme begun.

The phasing of the building plans has been worked out in detail and proposals for dollar requirements have been submitted to the Treasury. These involve a total dollar expenditure of approximately £15 million. This total is higher than the original sum of £9 million estimated in 1945, owing to the higher prices of plant in America and to some readjustment made necessary by limitations of construction in this country. The total expenditure in dollars represents about 7½ per cent of the Plan. Many of the items would not be obtainable in this country, but in the main the expenditure is designed to accelerate the completion of the Plan. Broadly, the extra time required to complete the Plan if dollar imports were cut down to very minor proportions would be approximately four years. The loss of exports and the additional imports required if the construction period were lengthened in this way would far more than offset the dollar expenditure involved in avoiding this delay.

TABLE VI.—*Rolling Mill Capacity*
(Tons)

	Present capacity.	New building.		Future capacity (on basis of schemes submitted).
		Original plan.	Schemes already submitted.	
Billet mills	3,700,000	2,200,000	1,000,000	4,400
Plate mills	1,750,000	500,000	350,000	1,750
Joists, rail and heavy section mills...	2,500,000	650,000	600,000	2,500
Sheet and tinplate mills	2,400,000	1,100,000	1,100,000	2,700
Light section, bar, rod and strip mills	3,175,000	1,000,000	650,000	3,500

American Engineering News

Design of American Dams

A report on hydraulic engineering by the American Society of Civil Engineers states there have been no new principles in the design of masonry dams, but that there is new activity in the study, particularly as to uplift water pressure and ice pressure on masonry dams. Construction of earth dams has been curtailed by war conditions, so that there have been no recent important developments either in design or in methods of construction. However, good practice will continue to depend upon the treatment of soil as a structural material. Present-day design of earth dams includes much greater spillway capacity than has been customary in earlier years, in order to ensure stability of foundation and embankment, reasonable watertightness and safety from overtopping. The embankment has a core or interior section of low permeability, with or without a foundation cut-off of soil, concrete or steel piling. Outer layers or shells are of coarser materials for drainage of seepage, with slopes flat enough to keep stresses within shearing resistance and to provide adequate stability. Recent trends in design are extreme precaution against overtopping, more extensive preliminary investigation of site, and adequate provision for safe discharge of such seepage as may pass through the so-called impervious portion of the dam. Both the hydraulic fill and rolled fill methods of construction continue in use, but the latter is gaining favour, largely because of the continuing development of soil transportation machinery of larger capacity and higher speed. Experience has indicated the importance of protecting the upstream face from erosion by wave-action by means of paving underlaid by a layer of coarse material. This material is to prevent the receding waves from washing out the embankment under the paving, as has occurred in some cases. Recent practice indicates a liberal use of random stone riprap or revetment for drainage and protection from waves. For control of foundation seepage, puddle is generally preferred to concrete.

Metallurgical Coke

Although most of the blast-furnace coke in the mid-west section of the United States—including the Chicago and St. Louis districts—is made from eastern coals shipped in from distances of 550 to 600 miles, there is study of the use of Illinois coal for this purpose. That State has reserves of high-volatile bituminous coal estimated at 150 billion tons, and research indicates that much of the low-sulphur coal may be used to make metallurgical coal by blending with eastern coals. Of 12 to 15 million tons of coal shipped in to the Chicago area annually, 50 per cent to 75 per cent is high-volatile bituminous, much or all of which might be replaced by Illinois coals mined within distances of 100 miles to 300 miles. The savings in cost of transportation might be partly balanced by higher moisture content, higher ash and lower coking power. Thus the problem of using Illinois coals in the production of metallurgical coke is a matter of experimental research in which the economics of the process must be a governing factor. Other factors are: (1) the preparation of coal at the mines; (2) selection of coal blends and the proportions of high-volatile and low-volatile coals; (3) coke oven operation adapted to the selected blends; (4) use of the coke in blast-furnaces. For about three years, one large blast-furnace plant has used a blend with 60 per cent to 75 per cent of Illinois coal in its coking ovens. All this coke is made in by-product ovens and is all used in the blast-furnaces. A steel company is also experimenting with Illinois coal in its coke ovens. Such ovens are usually 14in to 20in wide, 12in high and 40ft long, and are heated to about 2000 deg. Fah. Coal blends for coking must not expand to such an extent as to damage the oven walls, and it is thought that the pressure should not exceed 2 lb per square inch. The time of coking ranges from sixteen to twenty-four hours. A sample analysis of the coke shows 1·1 per cent volatile matter, 91·3 per cent fixed carbon, 7·6 per cent ash, and 0·73 per cent sulphur. On the basis of research and experimentation, it is considered that Illinois coal will become a normal raw material in the production of blast-furnace coke in the mid-West area.

Industrial and Labour Notes

The Steel Situation

The Lord President of the Council, Mr. Herbert Morrison, held the seventh in the series of press conferences, dealing with Britain's economic situation, on Wednesday of last week. Apart from a comment that the unemployment figure for May—332,000—was the lowest since the war, the major parts of Mr. Morrison's statement dealt with coal and steel.

With regard to steel, Mr. Morrison said that here was a shortage which had been threatening to replace the shortage of coal as our most vexatious and crippling bottleneck. The Government had reached the conclusion that it would be justified in increasing the allotment of coal and coke to the iron and steel industry for the summer months. The object, Mr. Morrison explained, was to give the industry something like its full requirements in the summer months, although it could not be guaranteed that in all cases the coal would be available in precisely the right qualities at the right places. The justification for giving the iron and steel industry additional fuel supplies was self-evident, for the demand for steel continued to run at very high levels indeed, and a substantial amount of steel output had been lost because of the fuel crisis.

Steel output, Mr. Morrison continued, had been high in recent weeks, but only at the expense of a serious running-down of stocks of pig-iron and scrap. Even if the industry were now enabled to produce at something like its maximum output, the amount of steel available in the summer would inevitably continue to fall below demand, owing to supplies from abroad not yet being available to us in the quantities we needed. It was expected that the broad effect of the increased fuel supplies would be that in the summer months, after allowing for the effect of holidays, the industry would be able to produce at about the same rate as had been achieved over the whole of 1946, namely, at about 12,700,000 ingot tons. Also, it was hoped to give sufficient fuel supplies to the industry in the winter months to push steel production in the last quarter of the year up to an annual rate of well over 13,000,000 ingot tons.

Mr. Morrison added that the maximum home production of steel was still not enough to meet the absolutely unprecedented demands for reconstruction, for re-equipment, for the export drive, and so on, which were the aftermath of war. Home capacity was only about four-fifths of our present need, and imports went only a little way towards filling the gap. Total home capacity could be increased but slowly, and imports from abroad could not in present conditions grow quickly. That was why the shortage must continue, and why no steel user should be misled into expecting the fulfilment of his unsatisfied demands for some time to come.

British Overseas Trade

From figures published by the Board of Trade, at the end of last week, it may be seen that the value of exports of United Kingdom goods in the month of May reached a total of £89,706,313, the highest figure to be achieved this year. The volume of exports in May is estimated as being 104 per cent of the 1938 average. The value of imports, which has been rising sharply since the beginning of the year, totalled £153,215,160 in May, and re-exports of imported merchandise amounted to a value of £7,061,375.

Analysing the month's export figures, the *Board of Trade Journal* says that the number of new motor cars exported in May, 10,670, was the highest on record, and was nearly three times the average monthly export in 1938. Exports of commercial vehicles, 4186, also recovered but were one-fifth below the average of the last quarter of 1946. Shipments of locomotives, however, were the lowest for nearly a year. Machinery exports generally declined during May, although machine tool exports reached a record figure of 4848 tons, or nearly two and a half times the monthly average of 1938. The reduction in the machinery group was greatest in agricultural implements the exports of which were the lowest for a year. There was an increase in exports of iron and steel and manufactures thereof, the May total being just over 164,100 tons, compared with 147,700 tons in April. The May figure just exceeded the 1938 monthly average.

Railway Wages

The Court of Inquiry appointed by the Minister of Labour to consider the railway trade unions' claims for increased wages and for a reduction in working hours has recently been meeting in public and, subsequently, in private session. Mr. C. W. Guillebaud, lecturer in economics in the University of Cambridge, presided over the Court.

The case for the unions was presented by representatives of the National Union of Railwaymen, the Associated Society of Locomotive Engineers and Firemen, the Railway Clerks' Association, and the unions allied to the Railway Shopmen's National Council. The claims included an all-round increase in wages of £1 a week, payment of double time from 4 p.m. on Saturday to midnight on Sunday, and a five-day week of forty-hours with a thirty-five-hour week of five days for clerical and supervisory staffs. In the evidence submitted, it was stated by Mr. W. P. Allen, of the Associated Society of Locomotive Engineers and Firemen, that many men had left railway service because of dissatisfaction with rates of pay and general conditions. The number of hours worked had risen to a "terrific figure" since last November, and he considered that in view of the responsibility placed on them, the demands of the locomotive men were not unreasonable. He added that the condition of many locomotives in use at present was worse than had ever been known in railway history. Mr. Benstead, the general secretary of the N.U.R., also supporting the claims, contended in his evidence that many outside factories had amenities far in advance of the railway workshops and said that it had been difficult for the unions to keep peace in the railway industry.

When the railway companies' evidence was presented to the Court, it was stated by Mr. H. Adams Clarke, on behalf of the four main line railways, that to give full effect to the claims, on a basis of a thirty-five-hour week for the salaried staff and a forty-hour-week for other staffs, would add about £90,000,000 to the wages bill, while a forty-four hour week would add about £60,000,000. The salaries and wages bill of the four companies in 1946 was £198,852,000. To meet the claims, Mr. Adams Clarke asserted, would mean a possible increase of passenger fares of 65 per cent and of freight charges of 70 per cent compared with the pre-war rates. He also said that any reduction of hours in the workshops, unless the companies could correspondingly increase output, would have a serious effect on the repair and construction of rolling stock which would adversely affect traffic. Sir William Wood, president of the L.M.S. executive, said he estimated that, for the whole of the current year, the net revenue earned by the railways would be £21,800,000 less than in 1946.

Coal Output

The Ministry of Fuel and Power announced on Tuesday last that, in the five weeks of May, the saleable output of mined coal in Great Britain averaged 3,581,400 tons a week and of opencast coal, 212,800 tons. The average weekly output during the four weeks of May in which a five-day week was worked was 3,516,800 tons of deep-mined coal and 198,900 tons of opencast. In May, 1946, the average weekly output was 3,702,500 tons of deep-mined and 217,500 tons of opencast coal. In the first two weeks of the present month the outputs of deep-mined coal were 3,660,600 tons and 3,691,200 tons, respectively, and on June 7th there were 716,600 wage-earners on colliery books.

The output per manshift worked at the coal-face averaged 2·86 tons for the whole of May and 2·88 tons in the period in which the five-day week was operating. Voluntary absenteeism averaged 6·01 per cent over the whole month and 4·65 per cent in the five-day weeks. In May, 1946, voluntary absenteeism was 9·46 per cent. The total tonnage of mined coal lost in the four five-day weeks of May, however, averaged 305,100 tons a week, of which recognised holidays accounted for 247,500 tons, disputes 34,200 tons, and accidents, breakdowns and repairs to machinery 20,900 tons.

The total inland consumption of coal was 3,390,000 tons a week in May and the provisional figure for the week ended June 7th was 3,228,200 tons. In the comparable week of 1946, inland consumption was 3,326,300 tons. The distributed coal stocks on June 7th were, according to a provisional estimate, 8,443,600 tons.

The A.E.U. National Committee

The annual conference of the Amalgamated Engineering Union's National Committee took place at Hastings during last week. It opened with an address by the President of the A.E.U., Mr. Jack Tanner, who, in commenting on home industrial affairs, said that only since the fuel crisis had we seen a practical recognition of the importance of engineering. The T.U.C.'s considered recommendations to the Government in connection with the Economic Survey had insisted that "the engineering industry must be mobilised, tooled and operated to produce maximum requirements in the minimum time," and it was gratifying to note that authoritative speakers were increasingly adopting that theme.

Mr. Tanner then went on to express the view that the trade union outlook and trade union machinery needed adjusting to the changing industrial situation, and, in conclusion, had a word to say about consultation and participation in management. In nationalised industries, he remarked, workers must obtain such participation to the fullest possible extent, but he pointed out that at the end of the present Parliament, 80 per cent of industry would still be privately owned. In private industry, Mr. Tanner continued, the workers "could not afford to be associated with the less pleasant aspects of management, but must largely confine participation to questions of production." Joint Production Committees, he thought, provided the most suitable method in such circumstances, and must be universally established and developed into the most effective medium for the purpose. It was essential, in order to give them official status and responsibility and to link their activities with the central plan, that they should be suitably connected with the Planning Board of the Government through the Regional Boards for Industry.

Among the resolutions passed at the conference was one relating to new wage demands in the engineering industry. With regard to the general wage structure, the resolution urged a national minimum consolidated rate, an increase in the piecework minimum to 33⅓ per cent, and a bonus agreement which would relate all time workers' earnings to piecework earnings. Furthermore, it recommended the conversion of some categories of workers at present designated as semi-skilled into the skilled grades.

French Engineering News

(From our French Correspondent)

PARIS, June 20th.

Monsieur Robert Cayrol, President of the "Carburant Modernisation Commission," envisages an increase of petrol imports from Iraq from one to three million tons by 1948. Consumption, which was about 6,500,000 tons in 1938, is expected to reach 11 million tons in 1950 and over 15 million tons in 1955. French policy is therefore concerned with production in Iraq and throughout the Middle East and with research, reconstruction of tankers and refineries, research on the chemistry of petrol and fuel oil alternatives, and the standardisation of transport and distribution methods so as to obtain the lowest prices possible. In France, North Africa and other French Union territory research is to be urgently undertaken. The pre-war tanker fleet carried about 40 per cent of total French imports. In future, French petrol tankers will carry at least 50 per cent of the imports, with emphasis on tankers of 16,500 and 21,500 tons, and later even higher tonnage. Refining capacity will also be increased. In 1938, out of 6,600,000 tons consumed, about 5½ million tons came from French refineries. Despite considerable destruction, capacity is expected to reach 5 million tons by the end of this year. Modernisation, to be undertaken in two stages, will increase refining capacity to 10 million tons in 1950 and 15 million tons in 1955.

* * *

Electrical construction work is still active and satisfactory. The Société pour le Travail Electrique des Metaux (T.E.M.) reports a turnover in 1946 twice that of 1945, which is only partly accounted for by higher prices. To meet current requirements, both in France and abroad, the society has begun modernisation and re-equipment of its plants and works and considerable expansion in production. The target is a 40 per cent increase in production capacity. The programme includes the construction of plant for making accumulators in cadmium-nickel, modernisation of the production of lead accumulators, and extension of shops for making transformers.

* * *

Strike movements and general dissatisfaction with hours and wages are hitting hard at the French effort at reconstruction of her industrial life. Strong efforts have and are being made by both sides to enlist public sympathy, and both the Government and the workers' leaders and committees are making statements to the Press, and billposting in public and at works and power and engineering plants, with a view to demonstrating their anxiety for nothing but a square deal. The Government is fighting fiercely to hold on to its freezing of wages, at any rate for a further six months. The labour side are promising to disturb the public as little as possible compatible with their pushing what they regard as their just claims. Skeleton maintenance staffs generally are keeping utility services and a certain amount of power and production going and servicing machinery and plant.

* * *

The Paris Fair closed at the end of May after having scored a record success. Although the total number of visitors has not yet been made known, it is known to exceed that of last year, when over 2,500,000 people visited the exhibition. At the traditional inventors' competition the first prize went to the inventor of a gear-changing mechanism for bicycles and the second prize was shared by inventors of an automatic machine for trimming hedges and of a bridge table for rapid distribution of the playing cards. A leading machine tool association manager told your correspondent that British exhibitors were quite satisfied with results from the point of view of French interest in British production, and inquiries were very plentiful. The difficulty was that the monetary situation prevented many firms from placing actual orders. There was much still to be done before British machinery and goods could be imported freely into France, he said.

Notes and Memoranda

Rail and Road

THE DARTFORD-PURFLEET TUNNEL.—The Minister of Transport stated in Parliament last week that tenders were about to be invited for the construction of the Dartford-Purfleet Tunnel. He was hoping that work on it would be started within the first two years of the ten-year transport plan but he could not give any definite undertaking.

A LONG LOAD.—A two-truck special train, carrying a long load consisting of two structural steel girders, each 102ft long and weighing 34 tons, was run by the G.W.R. and L.N.E.R., from Horsehay and Dawley to Hawarden Bridge recently. Owing to the unusual length of the girders and difficulties at curves, the G.W.R. kept the adjoining track between Horsehay and Wrexham clear of other traffic to ensure safe passage.

MOTOR VEHICLE PRODUCTION.—The monthly statistical review of the Society of Motor Manufacturers and Traders shows that in the month of April, 24,230 private motor-cars and taxicabs were produced in the United Kingdom, and 12,320 commercial vehicles, excluding battery electric vehicles. New registrations of motor vehicles in the month of March in Great Britain were 11,204 private motor-cars and 10,712 commercial vehicles.

A G.W.R. SHUNTING APPLIANCE.—An appliance resembling a small hand plough has just been introduced into this country from Belgium by the Great Western Railway and is to be used experimentally for shunting purposes in small goods yards where difficulty is experienced in providing locomotive power. It moves on a single wheel driven by a petrol-electric motor. The wheel is fitted with a rubber tyre with concave tread to enable it to run on a rail as well as on the ground. The machine, it is stated, will propel up to 150 tons, or approximately eight wagon loads.

Air and Water

CLYDE LAUNCHES.—During the month of May Clyde shipyards launched seven merchant ships, aggregating 20,450 tons, and H.M. submarine "Artful." In the first five months of this year thirty ships, aggregating 111,240 tons, have been launched on the Clyde.

MANPOWER IN THE ROYAL NAVY.—The Parliamentary Secretary to the Admiralty recently announced that the committee which is to examine the use of manpower in the Royal Navy has been constituted as follows:—Mr. J. T. Green, of Thos. Firth and John Brown, Ltd.; Mr. J. C. Little, Past-President of the A.E.U.; two senior naval officers; and one senior civil servant. His Honour T. Eastham, K.C., Senior Official Referee of the Supreme Court of Judicature, has consented to serve as Chairman of the Committee.

THE TRANS-TASMAN AIR SERVICE.—On April 30th the Trans-Tasman air service completed its seventh year of operation between Australia and New Zealand. Since 1940, a total of 33,000 passengers, 1,000,000 lb of mail and 50,000 lb of freight have been carried on 1900 flights across the Tasman, involving 2,500,000 miles flown. At first, one return flight was made each week, but this has been increased progressively and there are now seven flights a week each way. Until last year the service was maintained by two "Empire" class Short flying-boats, but the present fleet of Tasman Empire Airways, Ltd., consists of five aircraft, three 19-passenger "Empire" class flying-boats, and three 30-passenger "Tasman" class Short flying-boats. Another machine of this type is to be delivered this year.

STEVENAGE WATER SUPPLY.—The Minister of Town and Country Planning has received from D. Balfour and Sons, of Westminster, consulting engineers for the water supply at Stevenage, a report on the result of preliminary test pumpings, which shows that 3,000,000 gallons per day can easily be obtained. This, together with the existing supply, will provide for a consumption of 65 gallons per head per day for the new town's eventual population of 60,000. London's present consumption is 52 gallons per head per day. It is stated that the 3,000,000 gallons per day can be obtained from boreholes alone, without the costly wells and subterranean galleries, the necessity for which was at one time envisaged. The report suggests that many years are likely to elapse before the demand for water at Stevenage reaches this level, but other sources of supply are available when this becomes necessary.

Miscellanea

HANOVER TRADE FAIR.—An announcement issued by the Foreign Office (German Section) states that the first export Trade Fair for the display of goods produced in the joint U.S./U.K. Zones of occupation in Germany will be staged in the Vereinigte Leichtmetall Werke factory at Laatzen, approximately three miles from the centre of Hanover, from August 18th to September 7th, 1947. U. K. firms wishing to visit the fair should apply in writing to the Board of Trade, German Division, I. C. House, Millbank, S.W.1, giving details of products in which they are interested. Applications should be sent in as soon as possible.

TUNG OIL RESEARCH INSTITUTE.—According to *China Newsweek*, plans are being made for the establishment of a China Tung Oil Research Institute to improve the production and manufacture of tung oil, one of China's principal export commodities. The proposed Institute will be an independent organisation to be governed by a board of directors, with the Minister of Agriculture and Forestry and the Chairman of the Kwangsi Province serving as Hon. Chairman and Vice-Chairman of the board. The Institute will have its headquarters in Kweilin, Kwangsi, while branches will be set up in other tung oil producing provinces, such as Szechwan, Hunan, Hupeh and Chekiang.

THE ASSOCIATION OF CONSULTING ENGINEERS.—The annual luncheon of the Association of Consulting Engineers was held at the Waldorf Hotel, London, on Wednesday, June 18th, when Mr. G. Howard Humphreys, M.Inst.C.E., the Association's Chairman, presided over a large company of members and guests. The toast of "The Association of Consulting Engineers" was proposed by the Minister of Transport, the Right Hon. Alfred Barnes, M.P., who emphasised that there was no period in the history of the world when the experience and skill of the consulting engineer were more necessary than at present. The expansion that inevitably followed a time of war was expressed by a desire for improvements of all sorts, Mr. Barnes said, and the skill and capacity of the British engineer, which had proved so valuable during the war, would make a tremendous contribution to the work of reconstruction all over the world. After the Chairman had acknowledged the toast, Dr. J. F. Crowley proposed "The Guests," response to which was made by the Right Hon. J. A. Beasley, High Commissioner for Australia, and Mr. F. T. A. Ashton-Gwatkin, of the Foreign Office. The concluding toast was that of the "Chairman," which was proposed by Sir Cyril Kirkpatrick and was cordially supported by all present.

THE OLD CENTRALIANS DINNER.—The thirty-seventh dinner of the Old Centralians took place at the Drapers' Hall, London, E.C., on Monday evening, June 23rd. More than 180 Old Centralians and their guests were present and a very enjoyable evening was spent. The chair was taken by the President, Mr. F. H. Bramwell, F.C.G.I., and the principal guest was Sir Stafford Cripps, President of the Board of Trade. In proposing the toast of "The Old Centralians," Sir Stafford made a warm reference to the contribution made to the nation by the Finsbury Technical College and the City and Guilds Institute. Had there been a battle flag, he said, it would have carried such battle honours as "Mulberry," "Pluto," "Fido," and others. Since the closing of Cooper's Hill College, the City and Guilds Institute had done much to provide the technical and scientific skill required by the Indian railways and public services. He looked forward to further help being given, when the Government's India plan was consummated. He pleaded for a greater share for the engineer alongside his financial and administrative colleagues in furthering that national industrial development which was essential for our progress. The President, Mr. Bramwell, said that they welcomed Sir Stafford for his high office and his scientific and legal training, which helped him to appreciate the work of the engineer. When the housing problem had been solved, he hoped that it would be possible for a City and Guilds Hostel to be built for the students. It was, he thought, very necessary to increase our output of trained engineers and scientists, if we were to keep pace and lead in the competition between ourselves and the United States. The toast of "The Guests" was ably proposed by Sir Frederick Handley Page, F.C.G.I., in an amusing speech, and Sir Norman V. Kipping, Director-General of the Federation of British Industries replied. Tribute was justly paid to Mr. A. M. Holbein, the Secretary of the Old Centralians, for the excellent arrangements made.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Institute of Physics

Friday and Saturday, July 18th and 19th.—INDUSTRIAL RADIOLOGY GROUP: Electric Lamp Manufacturers' Association, 2, Savoy Hill, W.C.2. A Symposium on "Methods of Crack Detection."

Institution of Civil Engineers

Thursday and Friday, July 3rd and 4th.—NEWCASTLE-ON-TYNE ASSOCIATION: Summer meeting in Newcastle-on-Tyne.

Friday, July 4th.—BIRMINGHAM ASSOCIATION: Visit to Avonmouth Docks. 8.45 a.m.

Institution of Electrical Engineers

Saturday, July 26th.—N. MIDLAND STUDENTS: Summer Outing. 9 a.m.

Public Works Congress and Exhibition

Monday, July 21st, to Saturday, July 26th.—London, Olympia.

Royal Meteorological Society

Saturday, July 5th.—Summer meeting at Portsmouth.

Stephenson Locomotive Society

Saturday, June 28th.—Visits to Brighton works, Redhill and Brighton running sheds, Southern Railway.

Friday, July 4th.—Visit to Swindon Works, G.W.R.

Contracts

A CONTRACT has been placed with the British Thomson-Houston Company, Ltd., for the supply of the complete a.c. electrical equipment for five floating dredgers which will be used to cut a canal between Donjere and Mondragon, in the south of France. The supply to the dredgers will be at 13,500V, taken from overhead land-lines running parallel to the projected line of the canal, the low tension supply of 380V, 3 phase, 50 cycles being obtained from the secondary of a 1000-kVA transformer mounted on each dredger. The electrical equipment also includes high tension switchgear with protective equipment, low tension ironclad distribution switchboards, control gear, and a.c. induction motors, most of which are of the slipring induction type. The a.c. motors total 1080 h.p.; the bucket chain motor is of 350 h.p., and several motors ranging from 50 h.p. to 140 h.p. are required for the conveyer belt system used to convey the spoils to the shore. A sub-contract for the supply of motor control gear has been placed with Brookhirst Switchgear, Ltd.

Personal and Business

MR. NORMAN BILES, A.M.I.Mech.E., has been appointed publicity and advertising manager of C.A.V., Ltd.

MR. W. A. FAIRHURST has been appointed technical director of the Cement and Concrete Association.

MR. W. M. MCKENZIE has been appointed secretary and chief accountant of Bruce Peebles and Co., Ltd.

MR. S. F. STEWARD, of E. R. and F. Turner, Ltd., has been co-opted to the Council of the British Engineers' Association.

THE STOCKTON STEEL FOUNDRY COMPANY, LTD., announces that in future it will be known as Head Wrightson Steel Foundries, Ltd.

THE COLONIAL OFFICE announces that Mr. J. W. Duggan has been appointed assistant chief mechanical engineer in the Government Railway of Nigeria.

THE ROCKWELL MACHINE TOOL COMPANY, LTD., announces that its Midland area offices are now at 132, Steelhouse Lane, Birmingham, 4 (telephone, Central 3692).

MAJOR MALCOLM SCOTT SPEIR has retired from the position of Chief Officer for Scotland, London, Midland and Scottish Railway. He entered the service of the former Midland Railway in 1905.

THE GREAT WESTERN RAILWAY COMPANY announces the following appointments: Mr. A. N. Butland, assistant to chief engineer, Paddington; and Mr. P. H. Spence, assistant divisional engineer, Taunton.

A. C. WICKMAN, LTD., has been appointed sole selling agent for home and export (excepting Sweden) for the automatic hob and helical spline grinding machine manufactured by the Chatwood Safe and Engineering Company, Ltd.

MR. WALTER JOHNSON has retired from his position as secretary of Thos. W. Ward, Ltd., after fifty-nine years' service with the company. He is retaining his seat on the board. Mr. H. Beresford has been appointed to succeed him as secretary.

JAMES HOWDEN AND CO., LTD., announces the retirement from its board of Mr. J. B. McGillivray, who has been associated with the company for fifty-four years. Mr. J. S. Niven and Mr. H. L. Paul have been appointed directors.

THE BRITISH THOMSON-HOUSTON COMPANY, LTD. announces the following appointments: Mr. F. C. Barford, A.M.I.E.E., district manager, Newcastle-upon-Tyne, and Mr. J. Clement, M.I.E.E., district manager, Midlands area, at the Birmingham office.

DIAPLASTICS, LTD., radio heating equipment manufacturers, has been taken over recently by A. C. Wickman, Ltd. The board of the company has been reconstituted as follows: Hon. C. M. McLaren, chairman; Mr. A. H. Jarrard, Mr. G. C. Trowbridge, and Mr. E. A. Hyde.

SIR RONALD GARRETT has been re-elected chairman of Lloyd's Register of Shipping. Mr. Kenneth R. Pelly has been re-elected deputy-chairman and treasurer, and Mr. E. L. Jacobs, chairman of the sub-committees of classification. Sir George Higgins has been re-elected a member of the general committee.

THE MINISTER OF TRANSPORT has appointed Mr. P. E. Millbourn, chairman of Spencer (Melksham), Ltd., as Adviser on Shipping in Port. His functions will be to advise on and co-ordinate measures within the competency of the Minister of Transport to reduce the turn-round time of ships and connected problems in ports.

THE LONDON, MIDLAND AND SCOTTISH RAILWAY COMPANY announces the following appointments: Mr. J. Briggs, assistant chief engineer, Watford H.Q.; Mr. S. O. Cotton, engineer (structures), Watford H.Q.; Mr. H. B. Everard, engineer (permanent way), Watford H.Q.; Mr. R. L. McIlmoyle, assistant engineer (structures), Watford H.Q., and Mr. I. R. Frazer, engineer (Scotland), Glasgow.

THE BRITISH FOOD MACHINERY MANUFACTURERS' ASSOCIATION, of which Mr. Norman Neville is director, has been admitted to membership of the British Engineers' Association. Mr. Neville is also director of the British Chemical Plant Manufacturers' Association. The B.F.M.M.A. was formerly the Food Machinery Industrial and Export Group. Mr. E. H. Gilpin (Baker, Perkins, Ltd.) is Chairman of the new Association, and Dr. E. H. T. Hoblyn is secretary. The address of the Association is 26, Portland Place, London, W.1.

Reports on German and Japanese Industry

Limited numbers of copies of the reports of Intelligence Objectives Sub-Committees on German and Japanese Industry listed below can be obtained from H.M. Stationery Office at the prices stated.

No. of report.	Title.	Post free. s.	d.
B.I.O.S.:			
959	I.G. Farbenindustrie, Manufacture of Triphenylmethane Dyestuffs and Intermediates at Ludwigshafen and Hoechst	9	3
961	German Dyestuffs and Dyestuffs Intermediates: Azo and Lake Dyestuffs	15	3
967	Deutsche Vacuum Oel A.G., Hamburg, Germany: Fuels and Lubricants	14	4
972	German Small Nail and Tack Manufacture	2	2
988	German Dyestuffs and Dyestuffs Intermediates: Azoic Products, including Naphthols, Fast Salts, Nitrosamines and Rapid Fast Salts, Rapidogens	4	2
F.I.A.T.			
889	Urea Manufacture at the I.G. Farbenindustrie Plant at Oppau.	3	2
891	Duxochrome Photo Colour Prints.	4	8

Classified List No. 2 of Industrialists' Reports on Germany (Consolidated list of all reports published up to and including October 26th, 1946), price 6d. (post free 8d.).

Technical Index of Reports on Germany Industry (reports published up to and including July 27th, 1946), price 5s. (post free 5s. 3d.).

B.I.O.S.			
998	Investigation into the Design and Performance of the Volkswagon or German People's car.	12	4
F.I.A.T.			
432	The Manufacture of Refractories and Information concerning their use in the Iron and Steel Industry of Western Germany...	12	10
718	Fertilisers made by I. G. Farbenindustrie A. G. at Leuna and Piesteritz	5	2
720	German Techniques for Handling Acetylene in Chemical Operations	11	3
724	Miscellaneous Chemical Processes and Plastics Machinery	4	2
743	"K-3" Silicon Dioxide for Rubber Filler	1	7
746	Synthetic Mica Research	2	2
773	Titanium Products in Germany	5	8
774	Anhydrous Chlorides Manufacture	3	2
787	Precious Metal Refining and Fabrication	2	8
806	Gesellschaft fuer Linde's Eismaschinen (Linde-Frankl Oxygen Apparatus) Hollriegelskreuth ...	1	7
831	Sodium Sulfate Electrolysis with a Mercury Cathode	2	8
832	Hydrochloric Acid Electrolysis at Wolfen	1	1
833	Experimental Production of Chlorine by Oxidation of Hydrogen Chloride: I. G. Farbenindustrie, Oppau	2	2
844	German Concrete Shipbuilding during the war	2	1
860	The Production of Mono-Vinyl-acetate	3	8
866	The manufacture of Luvitherm Film: Unplasticized Polyvinyl Chloride Film	2	2
870	The Production of Styroflex Film: Oriented Polystyrene Film	2	1
REPORTS OF INDUSTRIAL TEAMS' VISITS TO GERMANY			
C.I.O.S.			
XXVIII-21.	German Submarine Rotary Wing Kite	2	8
B.I.O.S.			
33	The German Electric Lamp Industry	2	1
410	Some Electrical Factories in Berlin-British Zone	3	8
691	Some Aspects of Microbiological Research in Germany	1	7
696	The Manufacture of Phosphate Esters at Bitterfeld	2	1
731	Manufacture of Carbon Tetrachloride at I. G. Farben, Bitterfeld	4	2
734	German Brown Coal Industry ...	5	2
778	German Manufacture of Wires and Strips for Electrical Heating	2	8
797	The German Metal Rectifier Industry	2	2
821	Heavy Forging Equipment: Notes on German Heavy Hydraulic Forging Presses	3	2
860	Iron Powder: Notes on German Production Methods at Dusseldorfer Eisenhuetten-gesellschaft, and Deutsche Eisenwerke	2	1
876	Coke Oven Gas Separation by Linde: I. G. Oppau...	0	7
882	Aluminium Foil Production ...	3	2
896	The Manufacture of Zirconium-Potassium Fluoride, Zirconium Oxide and Zirconium Oxychloride	0	7
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926	Moulding Powders and Laminated Sheet: Interrogation of Dr. Eisenmann of Dynamit A. G. Troisdorf at Beltane Schools, S.W.19	1	1
928	German General Rubber Goods Industry: Part 2. For Part I see B.I.O.S. 349...	23	11
930	Preparation of Zinc by Electrolysis: Duisberg Kupfer Huette, Duisberg	1	7
935	I. G. Farbenindustrie, Ludwigshafen am Rhein: Manufacture of Phthalic Anhydride	1	1
962	Production of Tungsten Wire and Processing of Scheelite ...	4	8

B.I.O.S. Information Section, 37, Bryanston Square, W.1, which has at its disposal a considerable volume of information not in a form suitable for general reproduction, is prepared to receive enquiries regarding all problems relating to scientific and technical intelligence on both German and Japanese industry.

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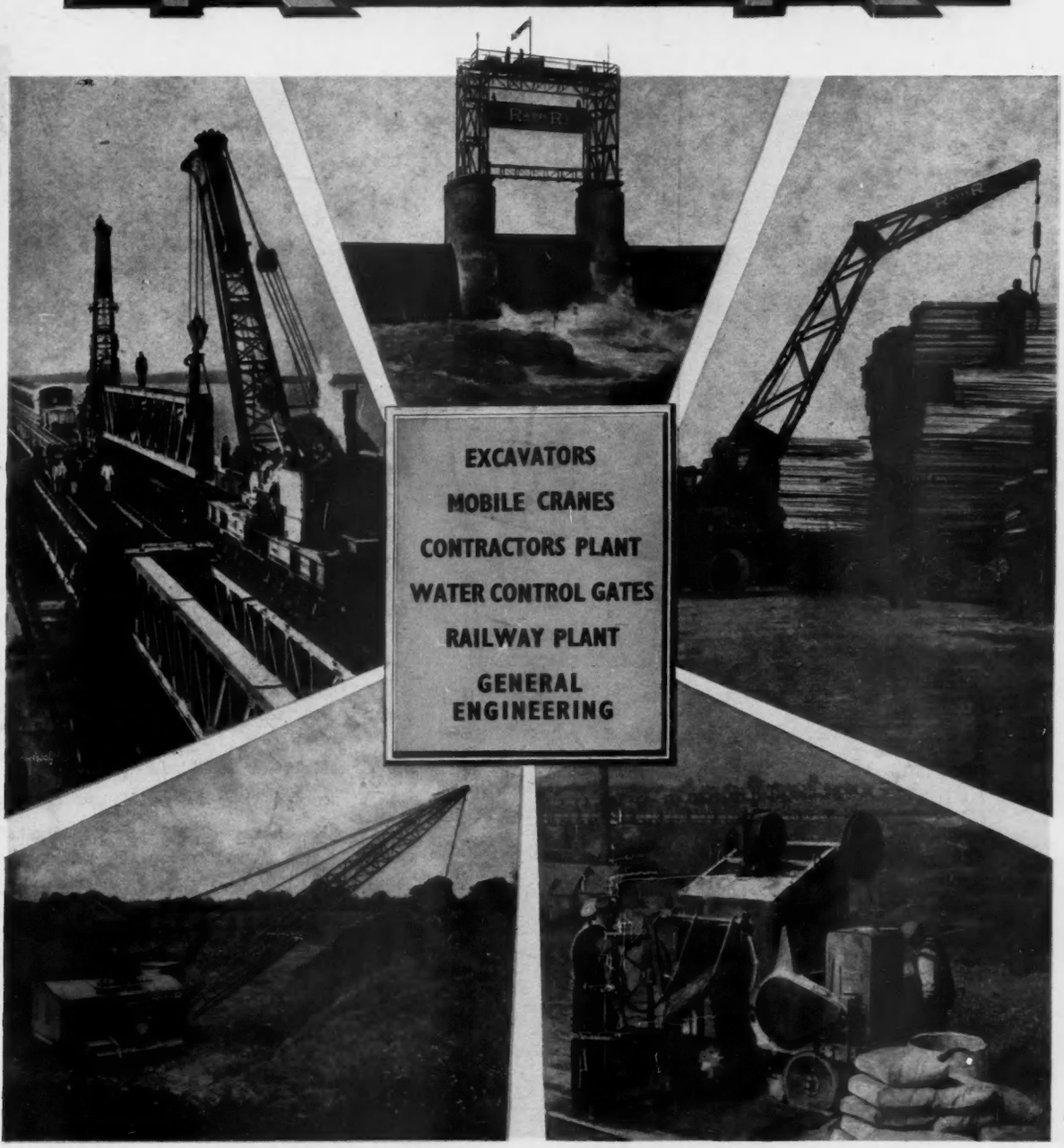

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This, the only establishment of its kind in Gt. Britain, provides intensive courses in casting and weld radiography (including Lloyd's Approved Courses) and in X-ray crystallography. Syllabus on request.